



50th Annual Fuze Conference

"50 Years of Support Freedom"

9 - 11 May 2006

Norfolk, Virginia

Session I & II: OPENING REMARKS AND KEYNOTE & GENERAL SESSION

- **Keynote: Mr. Rene Kiebler**, Deputy Project Manager Combat Ammunition Systems, PEO Ammunition
- OSD Perspective, **Mr. Peter A. Morrison**, Staff Specialist OUSD/DDR&E(S&T) Weapons Technology
- PEO Ammo Perspective, **Mr. Rene Kiebler**, Deputy Project Manager Combat Ammunition Systems, PEO Ammunition
- US Army RDECOM ARDEC Perspective, **Dr. Joseph Lannon**, US Army RDECOM ARDEC
- Navy Overview, **Mr. Steve Mitchell**, Ordnance Project Area Director, NAVSEA
- Air Force S & T Strategy, **Mr. Timothy Tobik**, Air Force Research Laboratory, Eglin
- Air Force Acquisition Strategy, **Mr. J. Rick Holder**, Sr., Director Fuze Squadron USAF, Eglin
- Fuze IPT Perspective, **Mr. Lawrence Fan**, Fuze and Microsystem Project Manager, NSWC

Session IIIA: OPEN SESSION

- PGMM, New Application for an Existing Fuze, **Mr. Al DeSantis**, Picatinny Arsenal, NJ
- Proximity Sensor for the Guided Multiple Launch Rocket System (GMLRS), **Mr. Robert P. Hertlein**, L3 Communications - KDI Precision Products
- Portable Excalibur Fire Control System, **Mr. Gregory Schneck**, US Army RDECOM ARDEC
- Enhanced Portable Inductive Artillery Fuze Setter (EPIAFS), **Mr. Tom Walker**, US Army RDECOM ARDEC Adelphi Fuze Division
- The Evolution of the DSU-33 C/B Proximity Sensor, A Success in Customer-Contractor Partnership, **Mr. Michael J. Balk**, ATK Ordnance Systems
- A New Fuze for an Electromagnetic Gun, **Mr. Barry Schwartz**, US Army RDECOM ARDEC
- Introduction of the Multi Option Fuze Artillery (MOFA) DM84 on 120mm Rifled Mortar, **Mr. Jochen Wagner**, JUNGHANS Feinwerktechnik

Session IVA: OPEN SESSION

- Challenges Associated with Development of the Affordable Weapon System Fuzing System, **Mr. John Hubert**, L-3/KDI Precision Products, Inc.
- FMU-139C/B. Electronic Bomb Fuze Design Update, **Mr. David Liberatore**, ATK
- Shipboard Submunition Fuze Safety and Reliability Enhancements, **Mr. John Kunstmann**, Indian Head Division, NSWC
- Thermal Battery Development - Reduced Product Variability Through 6-Sigma, Automation and Material, **Mr. Paul F. Schisselbauer** and **Mr. John Bostwick**, ATK
- Performance Testing of Lead-Free Stab Detonators, **Mr. Neha Mehta**, US Army RDECOM ARDEC
- TNO Research on EFI's in Relation to Insensitive Munitions, **Mr. Wim Prinse**, TNO Defence, Security and Safety

Session VA: OPEN SESSION

- High-G Mortar Electronic S&A Development and Flight Test, **Mr. Cuong Nguyen**, US Army RDECOM ARDEC
- Safe Separation Study for MK 437 Multi-Option Fuze for Navy (MOFN), **Mr. Brian Will**, NSWC, Dahlgren
- Navy Proximity Fuze Simulation with Embedded Tactical Software, **Mr. John Langan**, NSWC WD
- Inadequacy of Traditional Test Methods for Detection of Non-Hermetic Energetic Components, **Mr. Karl Rink**, University of Idaho
- Weapons Reliability How Modern Warfare has Changed the Requirement, **CDR Tom Hole**, USN, US Navy PMA-201
- MAFIS a Proven Hard Target Fuze, **Mr. Laurie Turner**, Thales Missile Electronics
- Aurora a Proven Hard Target Fuze, **Mr. Richard Clutterbuck**, Thales Missile Electronics

50th Annual Fuze Conference



Norfolk Waterside Marriott
May 9-11, 2006

50th Annual Fuze Conference

Administrative Remarks



- ☐ Number for phone messages at registration desk
 - 757-625-6467
 - ☐ Restrooms
 - Turn left out of ballroom and go to the end
 - ☐ 50th Anniversary Commemoration is followed by 1st Harry Diamond Fuze Excellence Award
 - Presented before lunch today
 - ☐ Tonight's reception at Nauticus / USS Wisconsin
 - Three blocks south of hotel
 - ☐ 2007 Fuze Conference
 - May 22-24, Gaylord Opryland in Nashville, TN
 - Turn off cell phones
 - Speakers give presentation to computer operators asap
-

50th Annual Fuze Conference

Wednesday, May 10



☐ Session I

- 8:00 Admin Remarks
- 8:10 [Keynote Address](#)

☐ Session II

- 8:40 [OSD Perspective](#)
- 9:00 [PEO Ammo Perspective](#)
- 9:20 [US Army RDECOM ARDEC Perspective](#)
- 9:40 [Navy Overview](#)
- 10:10 BREAK
- 10:30 [Air Force S&T Strategy](#)
- 10:50 [Air Force Acquisition Strategy](#)
- 11:10 [Fuze IPT Perspective](#)
- 11:30 Award Ceremony & 50th Conference Commemoration
- 12:00 LUNCH



308th Armament Systems Wing Eglin AFB, Florida

308th Armament System Wing



USAF Fuze Acquisition Roadmap Presentation to NDIA 50th Annual Fuze Conference 10 May 2006



*J. Rick Holder, Sr.
Eglin AFB, Florida
850-883-0842
james.holder@eglin.af.mil*

Distribution is not For Sale, Lease,
Or Co-Development.



Why Are We Here?

308th Armament System Wing

- **Fuze Acquisition Process**
- **Current Fuze Roadmaps**
- **Fuze Deficiencies**
- **Fuze Requirements**
- **AFRL & Foreign Technology**
 - **“Smart” Hard Target Fuzing**



USAF Fuze Acquisition Process

308th Armament System Wing

Three Methods of USAF Fuze Acquisition

1) Total System Approach (Eglin AFB)

- **308th Armament Systems Wing**
 - **308th Armament System Group**
 - JASSM (AGM-158)
 - **408th Armament Systems Group**
 - Wind Corrected Munition Dispenser
 - JSOW (AGM-154)
 - Sensor Fuzed Weapon
 - **918th Armament Systems Group**
 - Small Diameter Bomb I & II (GBU-39)
- **328th Armament Systems Wing**
 - **328th Armament Systems Group**
 - AMRAAM



USAF Fuze Acquisition Process (Cont)

308th Armament System Wing

Three Methods of USAF Fuze Acquisition (Cont)

2) Legacy System Approach (Eglin AFB)

- **308th Armament Systems Wing**
 - **708th Armament Systems Group**
 - FMU-152 (Joint Programmable Fuze)
 - DSU-33 (Proximity Sensor)

3) Sustainment Approach (Hill AFB)

- **784th Combat Sustainment Group**
 - **506th Combat Sustainment Squadron**
 - FMU-139 (Electronic Bomb Fuze)
 - FMU-143 (Electronic Bomb Fuze)



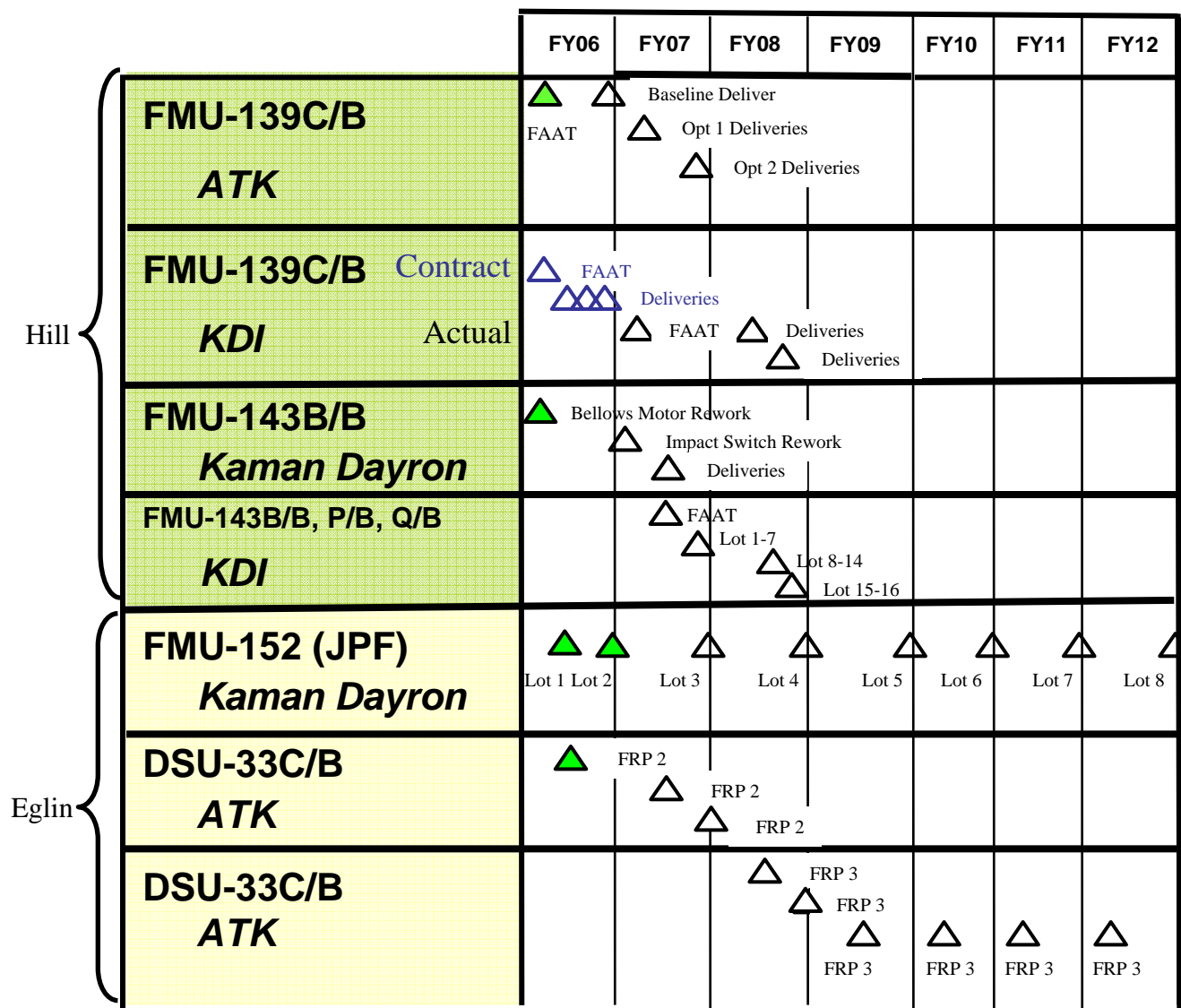
308th Armament System Wing

Approaches	FY	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
		Sep	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	1,2,3,4	
Total System																
JASSM (FMU-156/B) - Lockheed Martin																
JSOW-C (S&A) - Raytheon																
SFW (Integral, FZU-39) - Textron																
SDB (ESAD) - I ~ Boeing; II ~ Competition																
AMRAAM (FMU-49/B) - Raytheon																
Legacy System																
JPF (FMU-152A/B) - Kaman Dayron																
DSU-33 (Sensor) - ATK			B/B & C/B													
																C/B
Sustainment System																
FMU-139 -ATK			C/B													
-KDI			C/B													
FMU-143 - Kaman Dayron																
				B/B, P/B & Q/B												5



Component Fuze Roadmap

308th Armament System Wing





USAF Fuze Deficiencies

308th Armament System Wing

- **Requirement:** A fuze for Hard Target Munitions in support of existing Mission Need Statements (MNS)
 - CAF 314-90, Advanced Fuze Family MNS
 - CAF 317-92, The Hard and Deeply Buried Target Defeat Capability MNS
 - CAF 328-92, The Agent Defeat Weapon MNS

- **Shortcomings of Existing USAF Systems:**
 - No current fuze
 - Can survive impact loading above 10K g's
 - Has a void-sensing or layer-counting capability
 - Can arm & power-up at 60,000 feet
 - Can power-up at slow release speeds



Fuze Requirements

308th Armament System Wing

- **A “Intelligent” Hard Target Fuze**
 - Survive impact up to 50K g's
 - Sense changes in the target overburden and structure as the warhead penetrates the target
 - Provides a void-sensing or layer-counting capability
 - Initiate the warhead at a predetermined location within the target to maximize warhead effects
 - Power system must be self contained while meeting safety requirements
 - Operate at supersonic and very slow air speeds



Questions

308th Armament System Wing



50th Annual Fuze Conference



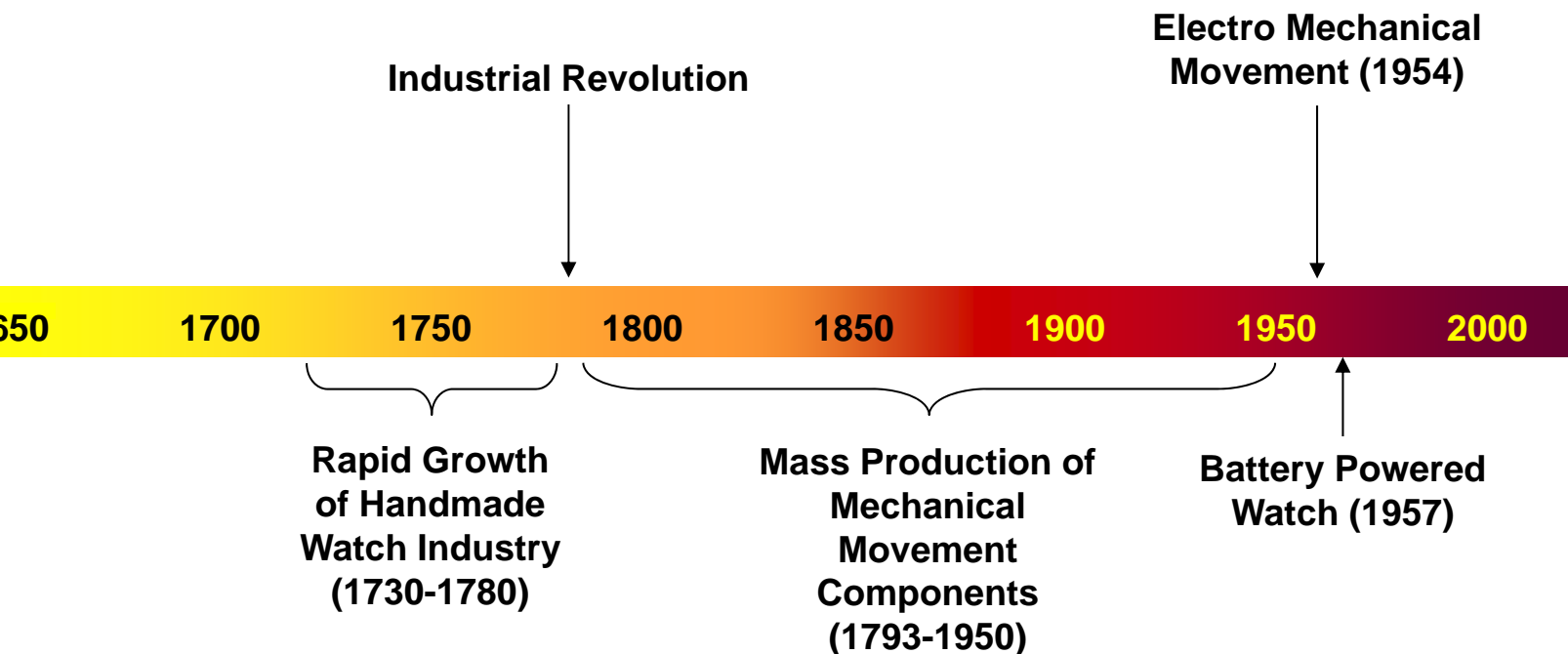
10 May 2006

Presented by: Mr. Rene C. Kiebler
Deputy Project Manager for Combat Ammunition Systems
973 724-2110, kiebler@pica.army.mil

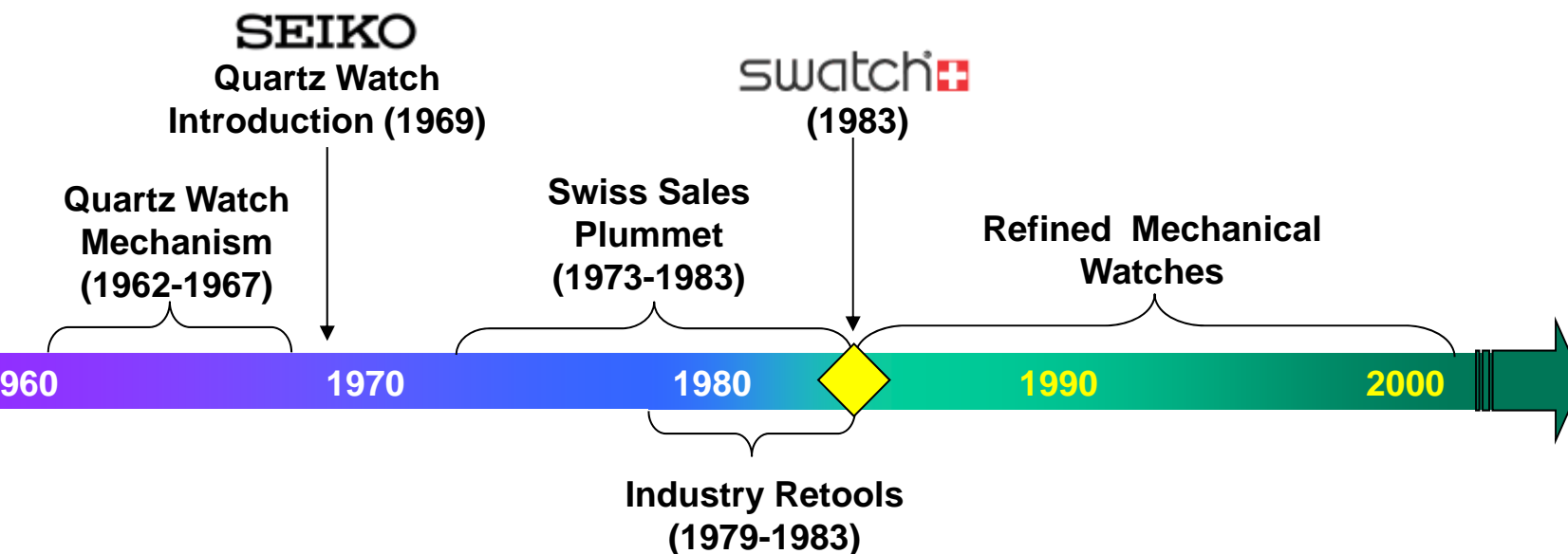
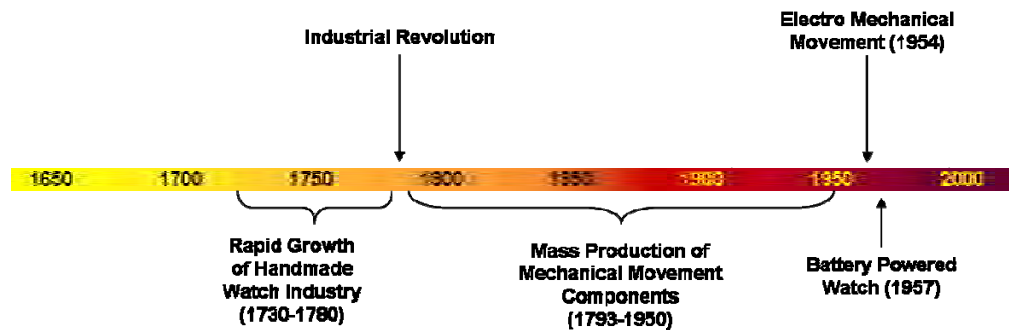




History of the Swiss Watch Industry



History of the Swiss Watch Industry



History of the Swiss Watch Industry



Mechanical Era



Electronic Era



Integrated Era



50

1800

1850

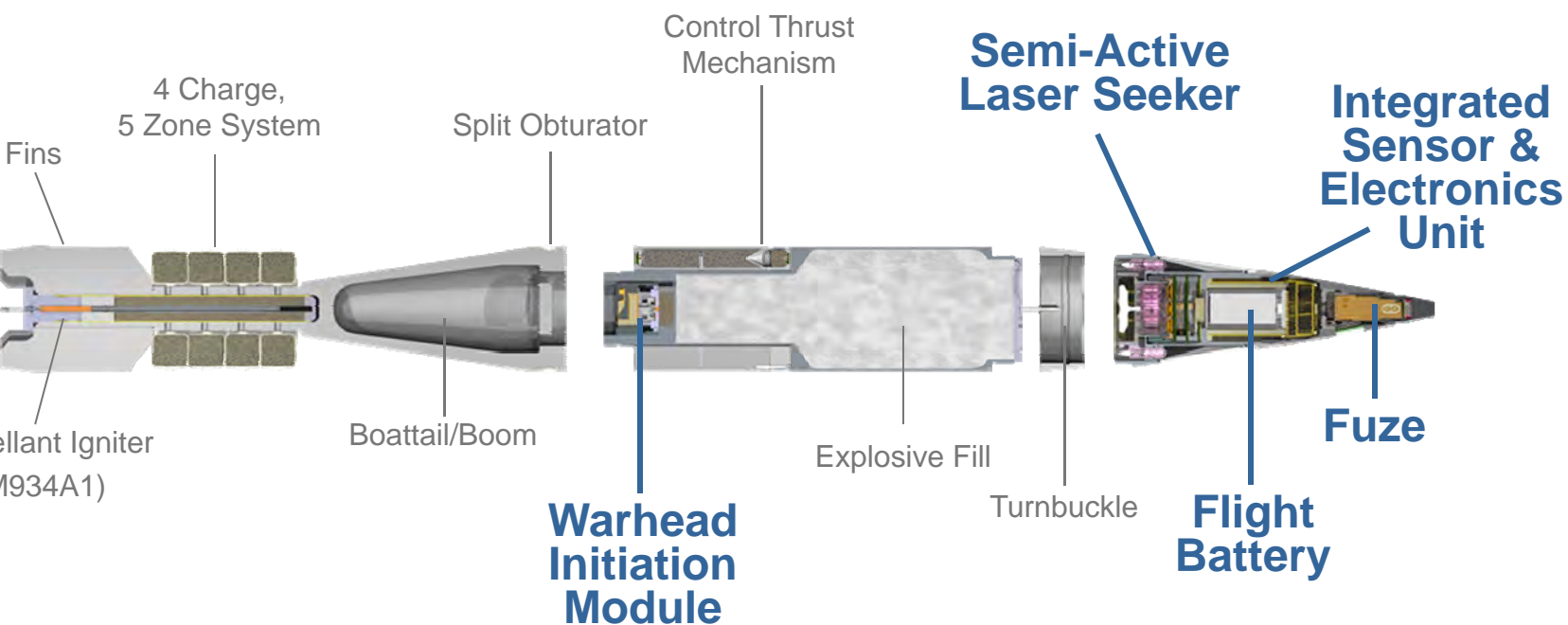
1900

1950

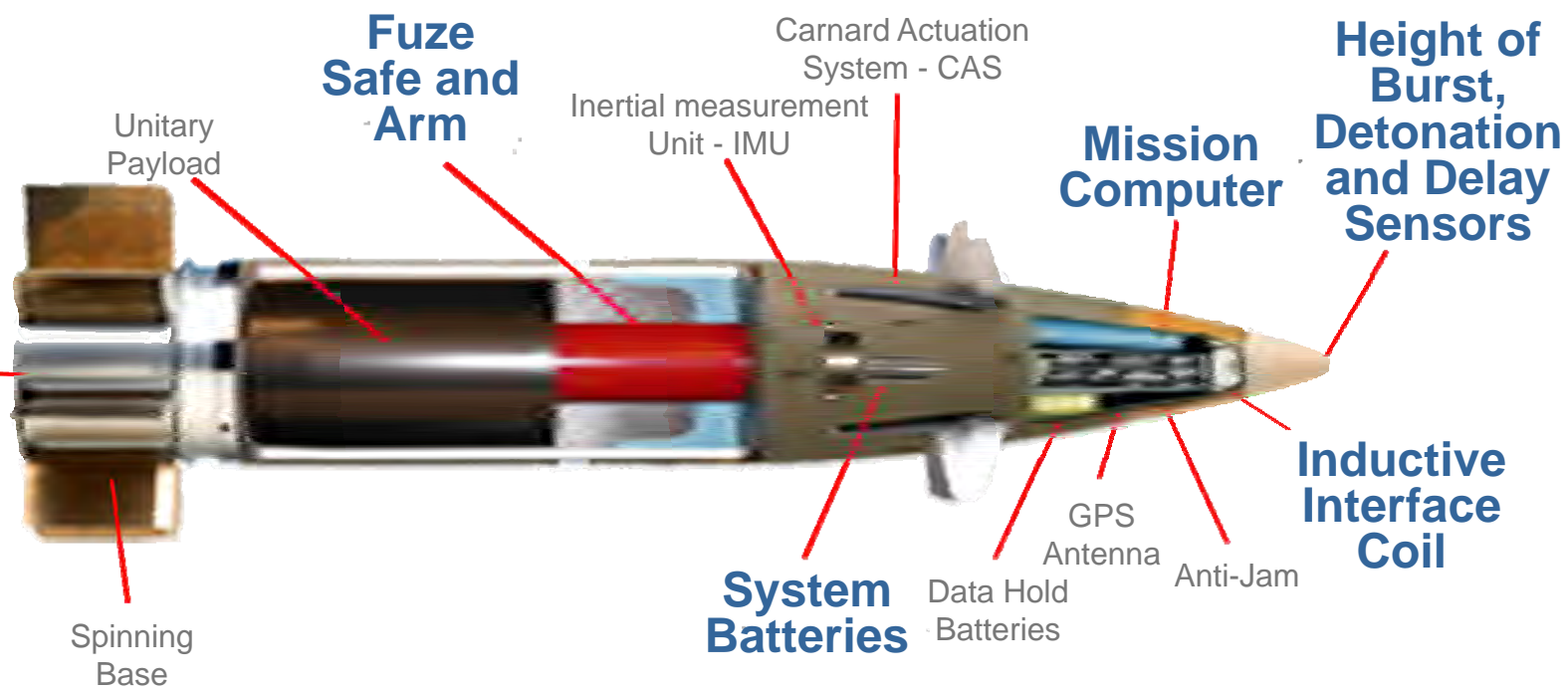
2000



PGMM Integrated Fuze

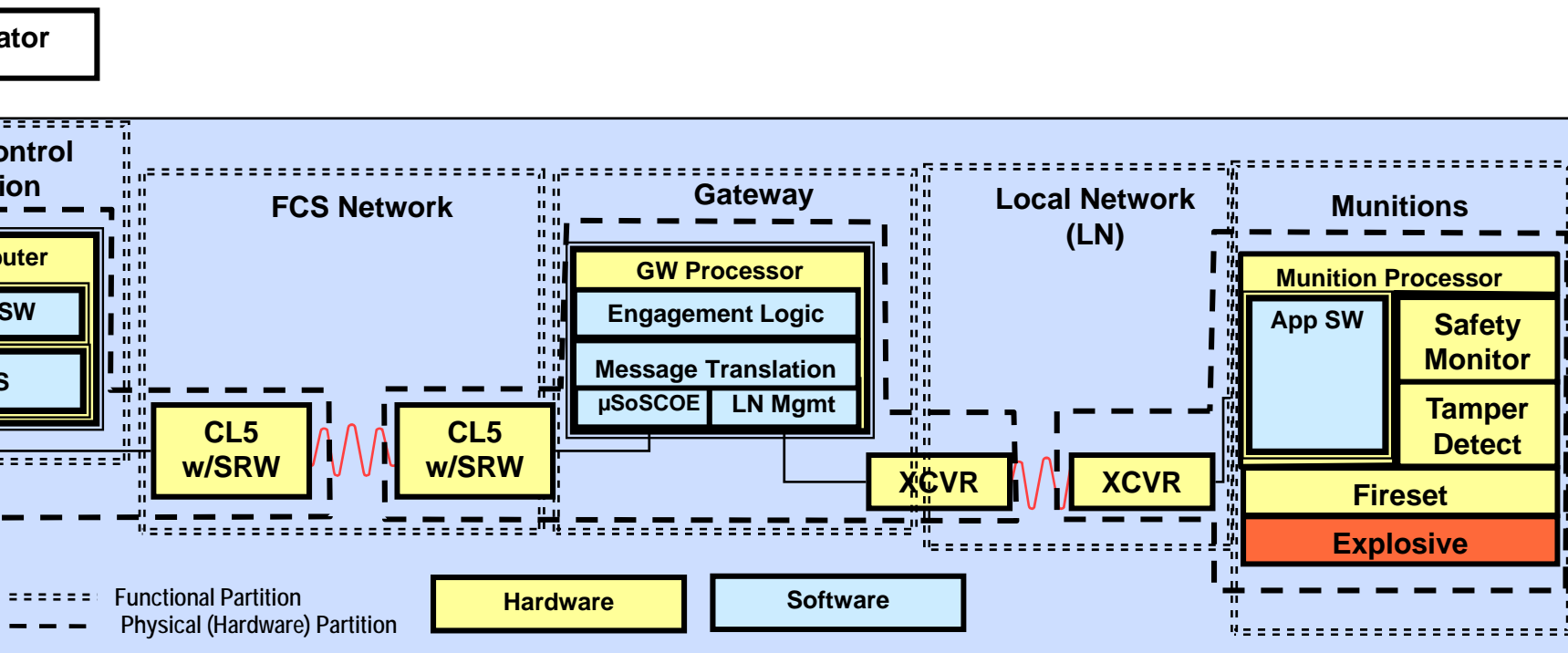


Excalibur Integrated Fuzing





Intelligent Munitions System (IMS) Distributed Initiation & Fuzing



For a networked munition system, the **initiation and fuze chain** begins at the **operator** & includes any **Hardware & Software** that plays a part in creating, processing, sending & receiving a message that will either cause or enable the munition to fire.

In addition, any Hardware or Software that plays a part in creating, processing, sending, receiving, storing, & displaying a status back from the munition that includes its armed/disarmed state is also **very critical**.



Existing Production Base



Do not over React/Abandon Mechanical Technology

Develop Retooling Strategy for Mechanical Technology

- ✓ Focused on Flexible Modern Processes
- ✓ Lower Unit Prices
- ✓ Maintaining Quality Levels

Adapt to Technology Advancement

- ✓ System Contractor Teaming
- ✓ Embrace Emerging Technology Innovations
- ✓ Aggressively Pursue Next Generation Markets
- ✓ Leverage Production Experience
- ✓ Develop Retooling Strategy

Aggressively Pursue Niche Markets

- ✓ FMS
- ✓ Legacy Buys



**Adapt or
Perish**



Government Agencies



Don't Abandon Mechanical/Electronic Technologies

Aggressively Pursue Technology Advancement

- ✓ Technology Development Contracts
- ✓ Foreign Technology
- ✓ Establishment of Fuze Technology Funding

Clarify/Rethink Requirements

- ✓ Service Safety Review Board
- ✓ Technology Independent/Flexible
- ✓ Responsive to Change
- ✓ Analytics and Data

**Safety is
Job #1**

Anticipate and Reduce Barriers to Foreign Markets

- ✓ Direct Sales
- ✓ Technology Alternatives
- ✓ Develop Upfront Constraints Workarounds
- ✓ Establish Process for Inventory Technology Upgrades





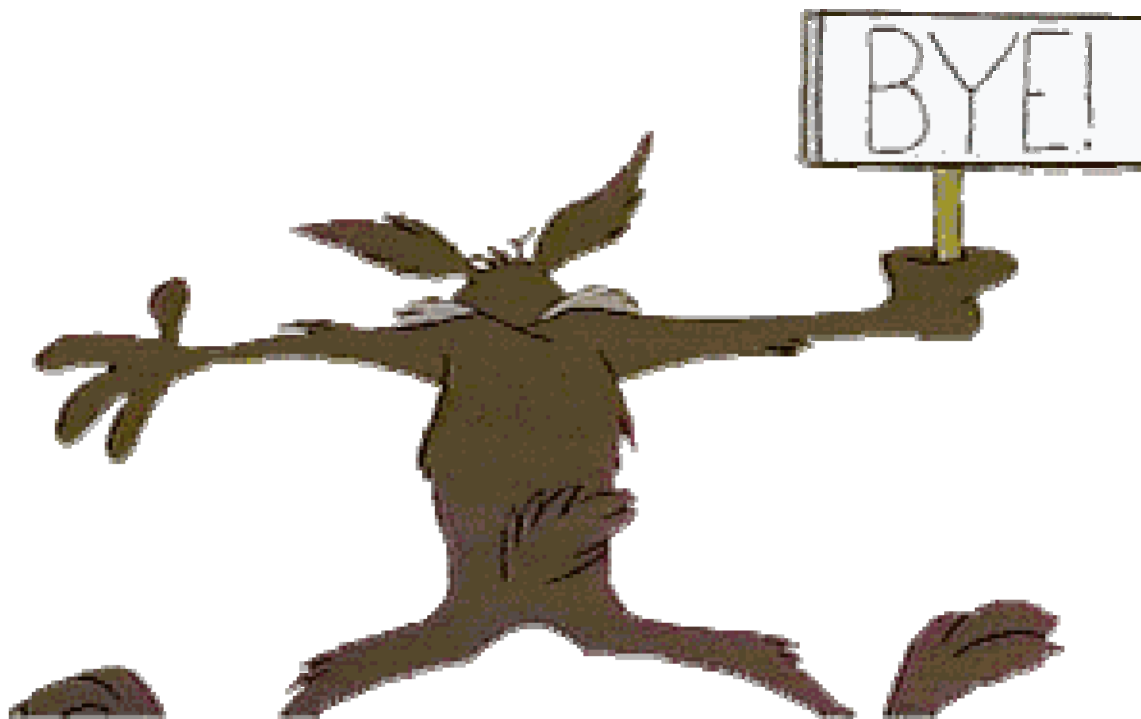
Systems Contractors



Understand Requirements/Process
Early Service Safety Review Board Review
Leverage Fuze Industrial Base Expertise

**Respect Fuze
Development
Process**

Questions??





Fuze Conference

May 2006

Rene C. Kiebler

Hooah!



Ammunition

Program Highlights

- ❖ Funds Overall Training Ammunition to 77% (Small Arms at 100%)
- ❖ Procures Modest War Reserves
- ❖ Funds Production Base
- ❖ Transportation, Testing

FY07

\$1,353M

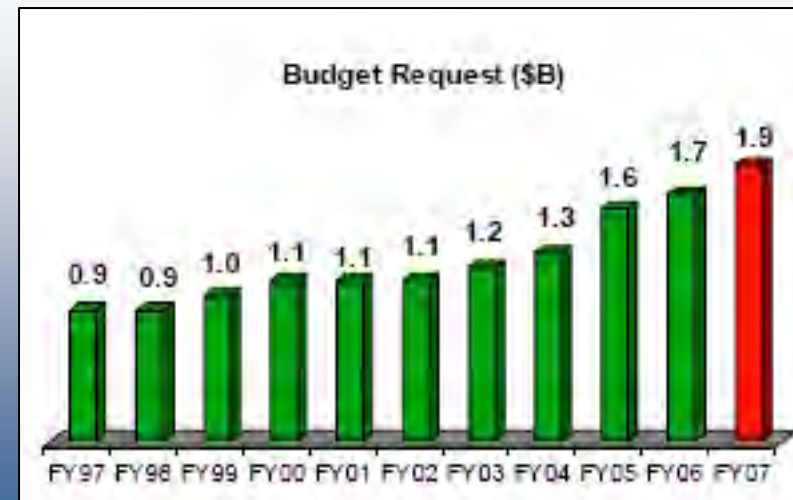
\$304M

\$221M

\$25M



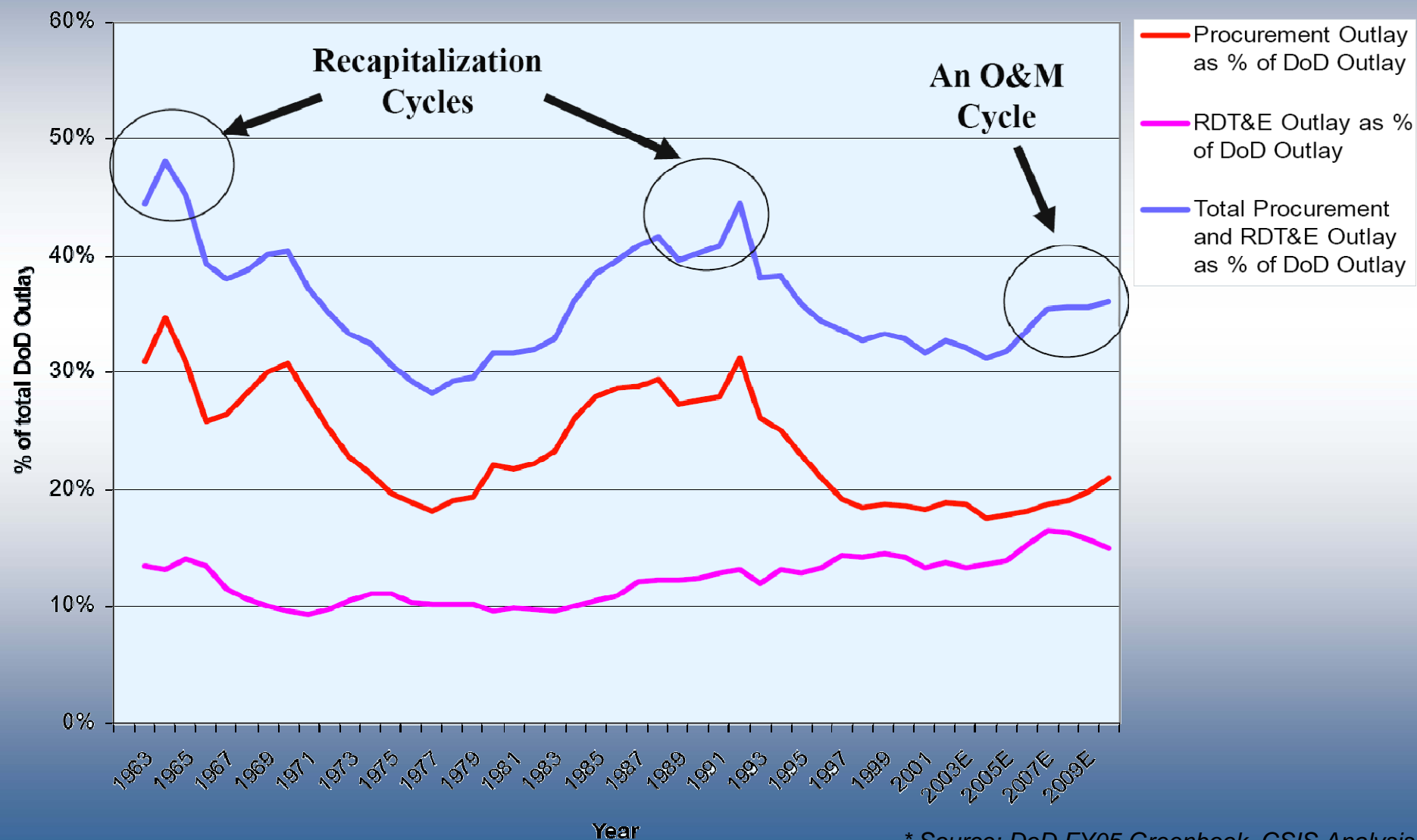
105mm M900 Anti-Tank



** Source: Army Budget Office*



Cycle Continues



* Source: DoD FY05 Greenbook. CSIS Analysis



Approach to 08 POM

- ❖ Use FY07 Pres. Budget as a start point
- ❖ Consider G3 / G8 Guidance
 - ✓ War Reserve: Procure War Reserve Quantity
 - ✓ Training Unique: 150 day training pipeline only
 - ✓ Training Standard: Fill War Reserve Quantity or increase the Mob Training requirement if WR is below annual training
- ❖ Assess Industrial Base impacts based on guidance
 - ✓ Is funding sufficient and allocated correctly



Assessment of Pres Bud to DA Guidance

<u>Family</u>	❖ <u>Meet Guidance</u>	❖ <u>Does Not meet Guidance</u>
❖ Artillery Fuzes	✓	
❖ 40MM All Types		✓
❖ 155MM All Types	✓	
❖ M228 Fuze		✓
❖ Counter Measure Flair		✓
❖ Smoke Grenades		✓
❖ MACS	✓	
❖ Small Caliber Ammo	✓	



Considerations to Preserve Current Industrial Base and Readiness

❖ Small Caliber Ammo

- ✓ Minimum buy of 1 billion rounds per year
 - Required for economic dual source strategy and future surge capability
 - Hedge against current requirements "uncertainties"

❖ Medium Cannon 25mm/30mm

- ✓ Minimum buy of 2 million rounds per year, 300K M789 HEDP for war reserve
 - Required for dual source strategy, reduce single point failures, mitigate increased cost
 - Maintain fuze production capability

❖ Aircraft Countermeasure Flares

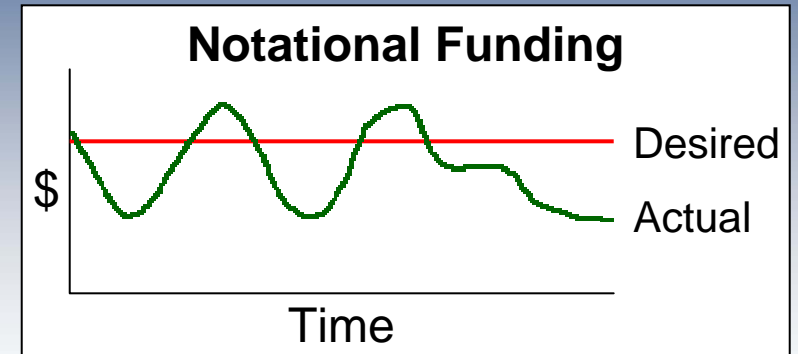
- ✓ Minimum buy of 635K per year (M211/M212 combined)
 - Support training and fill war reserve. Maintain wartime industrial base capacity (recently increased facility capacity)
 - Assumes AF continues to support the M206 base

❖ Tank Training

- ✓ Minimum buy of 80K M865A3 and 40K M1002
 - Required for dual source strategy, reduce single point failures, mitigate increased cost
 - Keep Tank Ammunition Production Base alive (Industrial Base as well as Engineering/Design) for future War Reserve production in support of FCS

❖ M228 Fuze, Training Hand Grenade

- ✓ Minimum buy of 6M per year
 - Minimally supports fuze production base





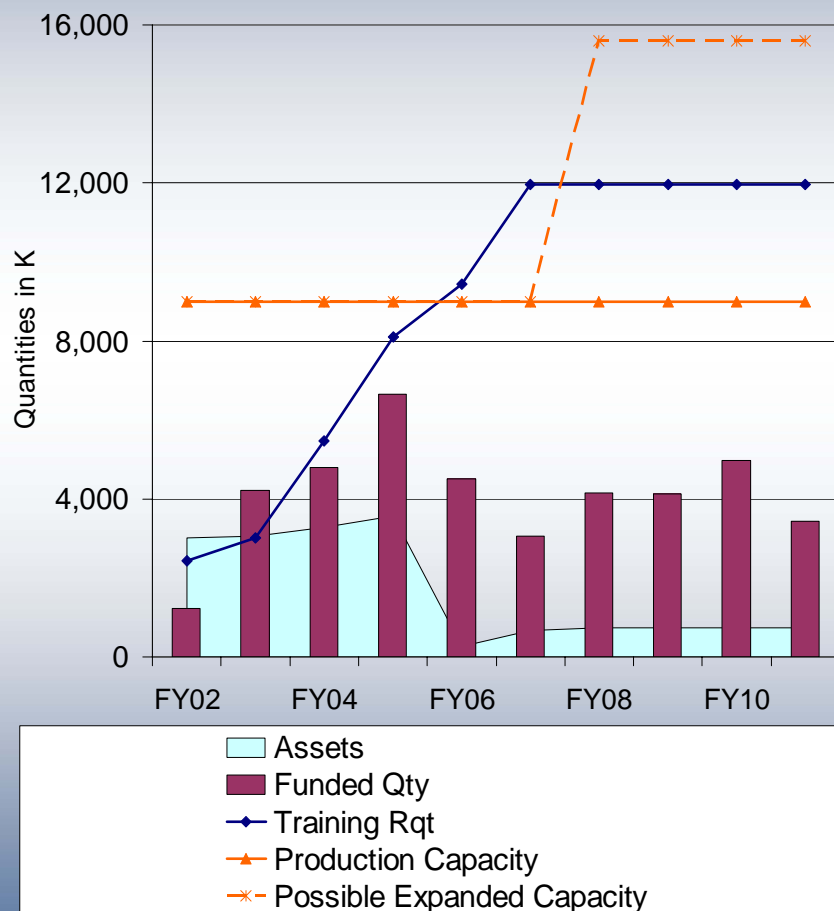
Bottom Line to Preserve Current Industrial Base

- ❖ **Maintain dual source strategy**
 - ✓ Mitigate cost increases
 - ✓ Reduce Single Point Failures
- ❖ **Maintain existing base to minimum sustaining levels**
- ❖ **Sustain expanded base capacity**
 - ✓ Small Cal
 - ✓ Flares

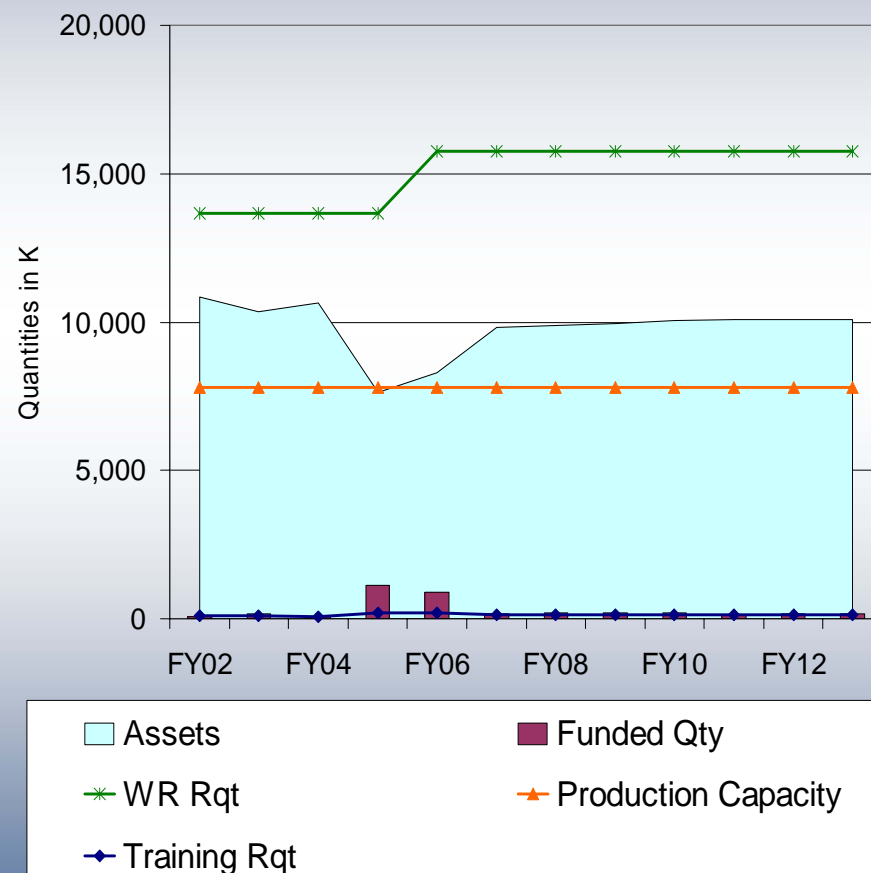


High Velocity Dilemma

Training Requirements



War Reserve Requirements



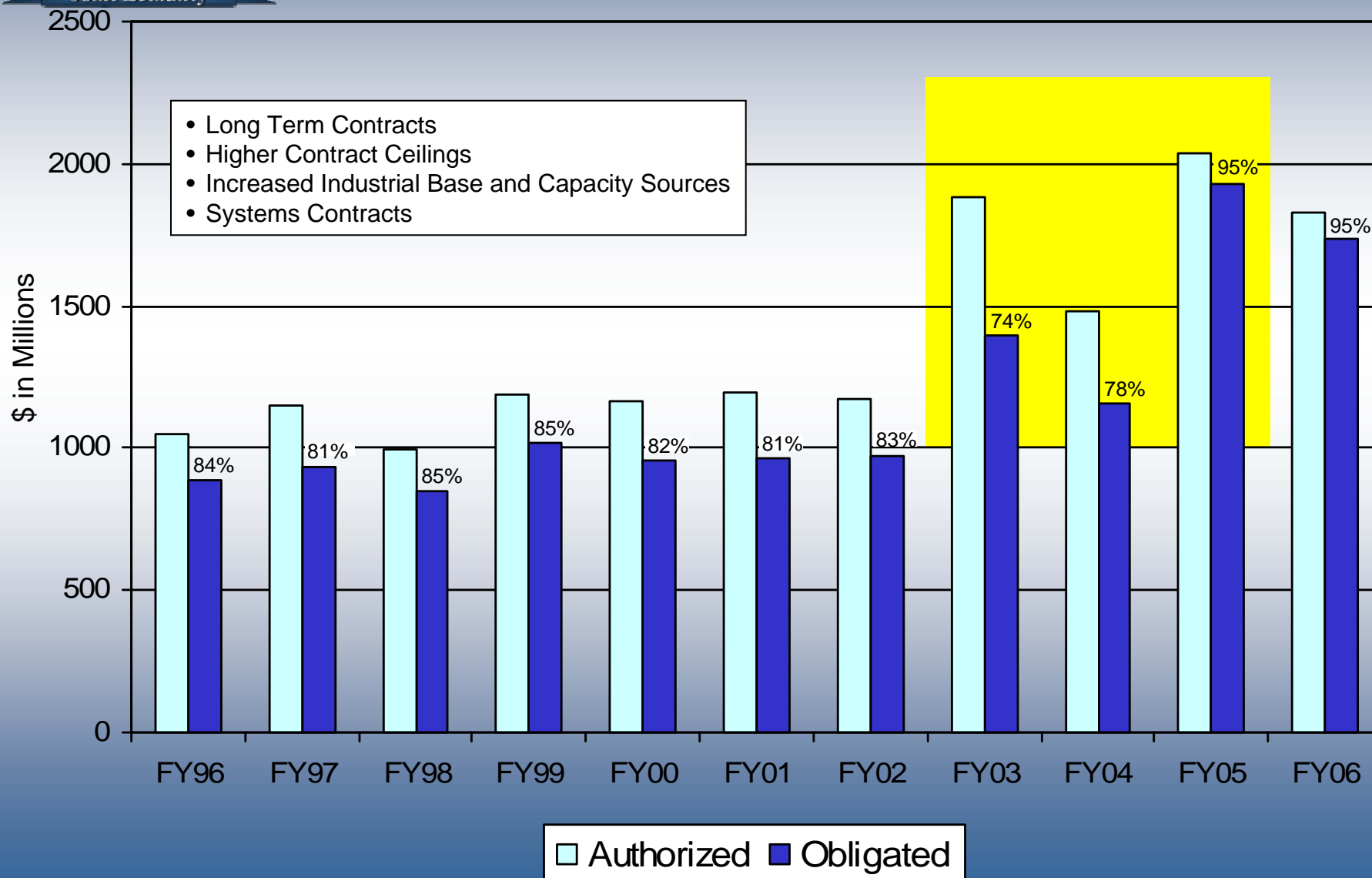
Training and Tactical: Underfunded

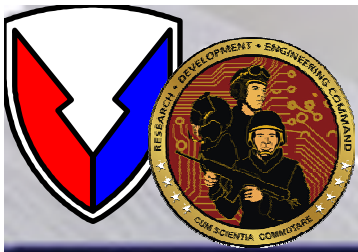


Ammo Executes its Funds

First Year Obligation Rate

(Including Supplementals)





50th Annual NDIA Fuze Conference

ARDEC Fuzing Overview



Presented by:
Dr Joseph Lannon
ARDEC Director
10 May 2006



U.S. Army Armament Research, Development, and Engineering Center (ARDEC)

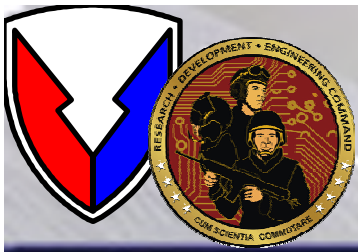


Vision:

Innovative Armaments Solutions for Today and Tomorrow

Mission:

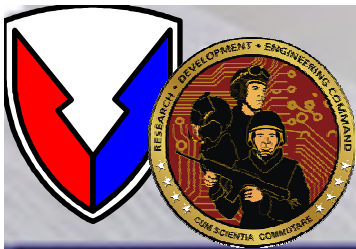
Execute and manage totally integrated life-cycle engineering processes required for the research, development, production, field support and demilitarization of ammunition, weapons, fire control, and associated items.



ARDEC Video



Click to start video.



ARDEC Organization Chart



OFFICE OF THE DIRECTOR
DIRECTOR
AMSRD-AAR-D
Dr. J. Lannon
X-6000
Deputy Director
AMSRD-AAR-DD
COL J. Merkwan
X-7000

ASSOC TECH DIR FOR SYS
 CONCEPTS & TECHNOLOGY

B. Machak (A)
 x7019

SPECIAL STAFF

IG: AMSRD-AAR-IG, J. Szatkiewicz, X6426
 IRAC: AMSRD-AAR-IR, D. Murawski, X6360
 Legal: AMSRD-AAR-GC, D. Scott (A), X3410
 SB: AMSRD-AAR-SB, R. Burdett, X4106
 OA: AMSRD-AAR-AO, P. Rowland, X7243
 EEO: AMSRD-AAR-EEO, R. Brown, X6368

FINANCIAL MANAGEMENT OFFICE

AMSRD-AAR-FM
 M. Manser
 X-8625

ARMAMENTS ENGINEERING TECHNOLOGY CENTER (AETC)

AMSRD-AAR-AE
 T. Sebasto/M. Ford (A)
 X6196/6197

ENTERPRISE MANAGEMENT (EM)

AMSRD-AAR-EM
 J. Hedderich III
 X-7016

ARMAMENT SYSTEMS INTEGRATION CENTER (ASIC)

AMSRD-AAR-AI
 COL S Crizer/P. Seroa
 X6006/6154

QUALITY ENGINEERING & SYSTEM ASSURANCE DIR

AMSRD-AAR-QE
 P. Chiodo
 X3918

WEAPON SYSTEMS & TECHNOLOGY DIR

AMSRD-AAR-AEW
 R. Fisoella
 DSN 374-5500

MUNITIONS SYSTEMS & TECHNOLOGY DIR

AMSRD-AAR-AEM
 S. Musalli
 X6446

STRATEGIC MGT OFFICE

AMSRD-AAR-EMS
 D. Denery
 X6081

PORTFOLIO MGT OFFICE

AMSRD-AAR-EMP
 R. Benjamin
 X7854

PROJ INTEGRATION OFFICE

AMSRD-AAR-AIP
 G. Berg
 X6906

LOGISTICS RESEARCH & ENGINEERING DIR

AMSRD-AAR-AIL
 R. Rossi
 X2168

FIRE CONTROL SYSTEMS & TECHNOLOGY DIR

AMSRD-AAR-AEF
 A. D'Agosto
 X3439

EXPLOSIVE ORDNANCE DISPOSAL TECHNOLOGY DIR

AMSRD-AAR-AEX
 J. Wu
 X7643

BUSINESS INTERFACE OFFICE

AMSRD-AAR-EMB
 J. Brescia
 X5010

KNOWLEDGE MANAGEMENT OFFICE

AMSRD-AAR-EMK
 G. Albinson
 X7376

JOINT SERVICE SMALL ARMS PROGRAM OFFICE

AMSRD-AAR-AIJ
 J. Goldman
 X6060

SYSTEMS ENGINEERING, ANALYSIS & CONFIGURATION MGT DIR

AMSRD-AAR-AIS
 J. Dyer
 x4707
 AMSRD-AAR-AIS-R
 A. Heyderman (RIA)
 DSN 793-6339

ENERGETIC WARHEADS & ENVIRONMENTAL TECHNOLOGY DIR

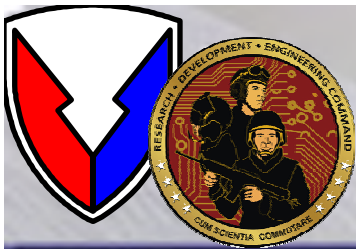
AMSRD-AAR-AEE
 C. Anderson
 X4287

FUZE & PRECISION ARMAMENTS TECHNOLOGY DIR

AMSRD-AAR-AEP
 Phil Gorman (A)
 X7307

ARMY FUZE MANAGEMENT OFFICE

AMSRD-AAR-AIF
 L. Springer
 X6842



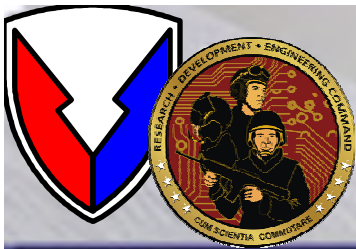
U.S. ARMY FUZE MANAGEMENT OFFICE

Summary of Responsibilities



- ▲ **Centralized Life Cycle Oversight Management of All Non-Nuclear Army Fuzes**
 - ▲ Focal Point for PEO Ammo on Fuzing Issues
- ▲ **Ensure proper execution of fuze RDA programs**
 - ➔ Appropriate designs
 - ➔ User needs
 - ➔ Applicable standards
- ▲ **Intensive management of designated programs**
- ▲ **Guidance and Input To PEO/PM Community on Fuzing Issues**
- ▲ **Coordinate Fuze Tech Base Programs**
- ▲ **Propose, Recommend and Support Actions Directed Towards Ensuring the Fuze Industrial Base Is Properly Maintained**
- ▲ **Army's focal point for multi-service and international fuzing interaction**
 - ➔ NATO AC310 SGII
 - ➔ DoD FESWG
 - ➔ JOCG Fuze Subgroup
 - ➔ DoD Fuze IPT
 - ➔ Munition Control case disposition
- ▲ **Chair and Manage The Army Fuze Safety Review Board**





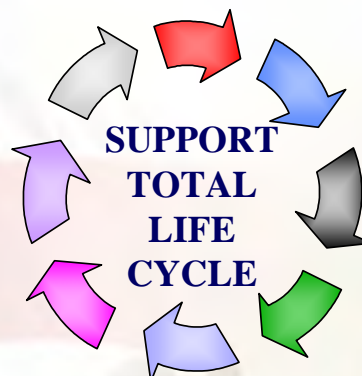
ARDEC Fuze Division

- Total Life Cycle Fuzing Responsibility
- Fuze Products
 - Proximity, Time, Point Detonating & Delay Fuzes
 - Artillery, Mortars, Tank, Med / Sm Cal,
 - Missiles & Rockets, Networked Munitions,
 - Mines & Demo, Non-Lethal
 - Safe and Arming (S&A) Devices
 - Mechanical / Electro-Mechanical
 - Electronic S&A (ESA)
 - Fuze Setters
 - Advanced Sensors



Customers/Interfaces

- ❖ User Communities
 - Ft. Benning
 - Ft. Sill
- ❖ PEO Ammunition
 - PM CAS
 - PM MAS
 - PM CCS
- ❖ PEO Soldier
- ❖ PEO GCS
- ❖ Army Fuze Management Office (AFMO),
- ❖ PEO Missile & Space
 - PM CCWS
 - PM JAMS
- ❖ AMRDEC
- ❖ National & International Fuze Related Committees
- ❖ AFSRB
- ❖ DoD Fuze Committees



**Fuze Competency Resides In
The ARDEC Fuze Division**

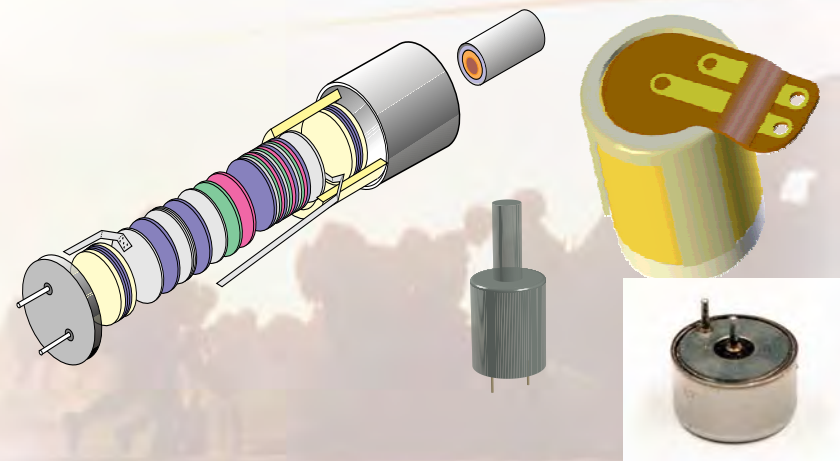
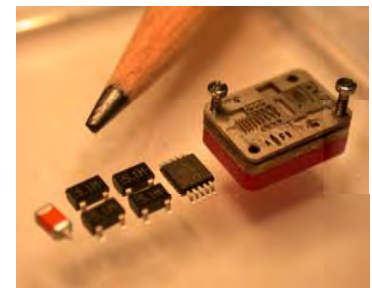


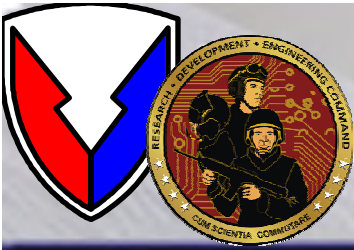
Army Technology Objective

Fuze and Power for Advanced Munitions



- User Payoff:
 - **Fuze Components**
 - Multipurpose & Multimode Capability
 - Customizable Lethality
 - Increased Safety
 - Affordability
 - **Power Sources** (Advanced On-Board Munitions Power Systems)
 - Increased Energy and Power Densities
 - Enables Longer Range Performance
 - Improved Producibility
 - Decreased Emphasis on Single Battery Solutions





Army Technology Objective Fuze and Power for Advanced Munitions

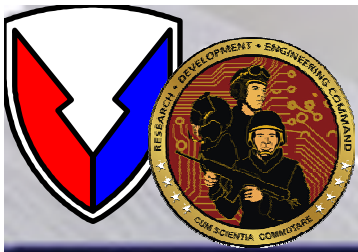


• Fuze Technology Thrusts:

- Multi-point Electronic Safe & Arming Devices (ESAD)
- Micro Electro-Mechanical Systems (MEMS) Safe & Arming (S&A)
 - Large Caliber Applications
- Advanced Sensors
 - Proximity Sensors For Direct Fire Applications
 - Environmental Sensors / Impact Sensors

• Power Source Technology Thrusts:

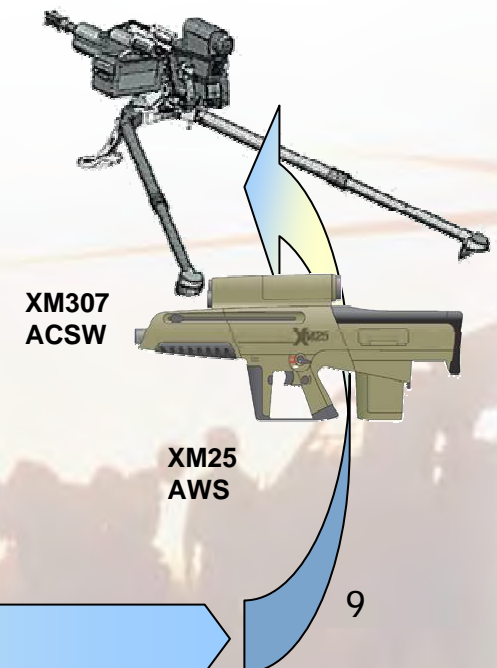
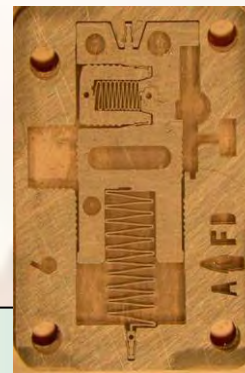
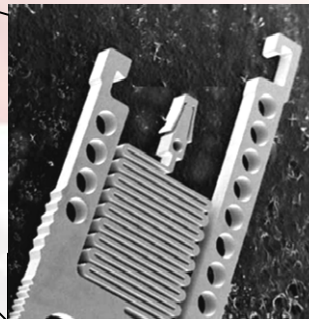
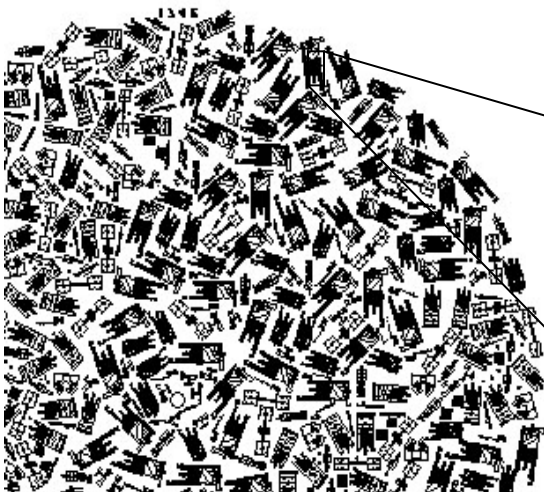
- Thermal Battery Prototypes
 - Higher Energy Densities In A Smaller Volume
- Novel Liquid Reserve Battery Prototypes
 - More Producible and Cost Effective
- Hybrid Power System Prototypes
 - RF Energy Harvester
 - Piezo Electric Harvester
 - Thermophotovoltaic
 - Super Conductors



Army Manufacturing Technology Objective - MEMS Safe and Arming



- Technology Thrusts:
 - MEMS-Based S&A Device Producibility
 - Scaleable Micro-Scale Explosive Loading Technologies
 - Common Device Form Factor for Medium and Large Caliber Applications
- Payoff:
 - High Volume Manufacturing Capability
 - Technology Affordability

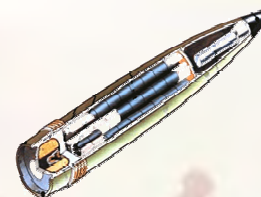


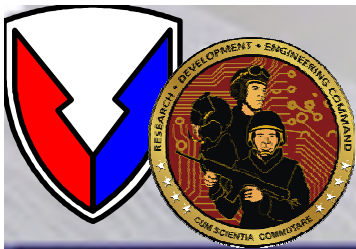


ARDEC Fuze Division Developmental Programs



- **XM784/785 ET Mortar Fuze**
- **XM395 PGMM Fuzing**
- **Precision Guidance Kit (PGK)**
- **EPIAFS**
- **XM 982 EXCALIBUR (integral Fuze)**
- **Medium Caliber Bursting Munitions**
 - XM25 – Shoulder Fired Weapon
 - XM307 Advanced Crew Served Weapon (ACSW)
- **40 mm Proximity Fuzing**
 - Lethal & Non- Lethal
- **Line Of Sight – Multi-Purpose (LOS – MP) – ARDEC ATO**
- **Self Destruct Fuze for M864 RECAP**
 - M223E1 (BTFP) & XM242 (ATK / IMI)
- **Network Munitions**
 - Spider
 - Intelligent Munition System (IMS)





ARDEC Fuze Division Production Programs

Artillery Fuzes

- M782 Multi-Option Fuze for Artillery (MOFA)
- M762A1/767A1 Artillery Electronic Time (ET) Fuze
- M234 Self-destruct Fuze
- M1155 PIAFS

Mortar Fuzes

- M734A1 Multi-Option Fuze for Mortars
- M783 Point Detonating Fuze for Mortars
- M772/M776 Mechanical Time Fuzes
- Mortar Practice Fuzes
- M935 Point Detonating/Delay

Grenade Fuzing

- M213 for M67 Grenade
- M228 Practice for M69
- M201A1 for M18 Smoke
- M201A1 MOD 2 for Stun Grenade

Countermine/Demolitions/AT Munitions

- APOBS Fuzing
- M1134A3 for MICLIC
- M147 TDFD
- M87A1 Volcano

Rocket/Missile Fuzing

- M423, M439, M442 – 2.75 in. rocket
- MK 420-BD

Medium Caliber Fuzes

- M549/M549A1
- M759 (30mm)
- M550 Escapement (S&A)



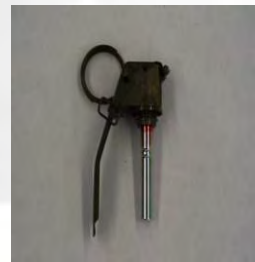
M1155



MOFA



M734A1



M228



M789 w/M759 Fuze



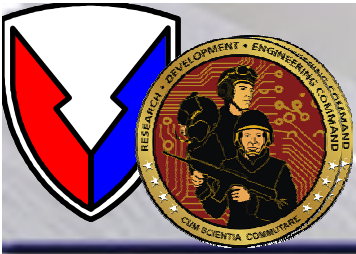
M762A1/767A1



APOBS Fuzing

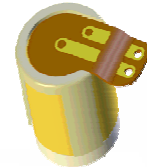
Tank Fuzes

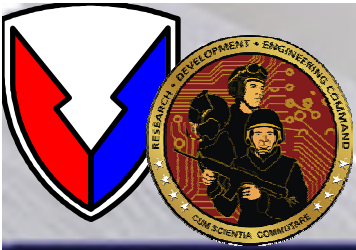
- M774 Point Initiating Base Detonating (M830A1)
- M74 Proximity Switch (M830A1)
- M578E1 Base Detonating (M393 Cartridge)



Fuze Technology Integration

- Technology Insertion To Current Munition Items
- Addresses Industrial Base Single Point Failure Issues
 - Risk Mitigation:
 - Battery Aging / Battery Airgun Test Facility
 - Signal Processor / MMIC Transceiver 2nd Source
 - M74 Proximity Switch
 - Block Upgrades:
 - Improved Bunker Defeat Munition Sensor
 - Update M734A1 Signal Processor
 - 2nd Env Safety Sensor Using Optics
- PEO Ammunition / User Payoff:
 - Insert Current Technology Into Today's Munitions
 - Preclude Obsolescence By Incorporating Component Technology
 - Provide Safer, More Reliable and More Lethal Munitions





Fuze Division Success Stories



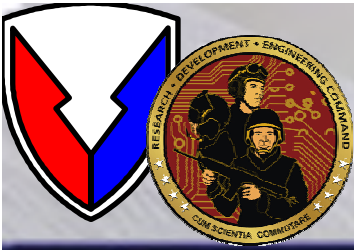
- XM784 / XM785 Mortar Electronic Time (ET) Fuze
 - Successful Ballistic Testing: Feb 06
- M782 Multi-Option Fuze for Artillery (MOFA)
 - Materiel Release: Nov 05
- Self Destruct Fuze for M864 Recapitalization (RECAP)
 - M223E1 (BTFP) Successful Engineering Test
 - XM242 (ATK / IMI) Successful Engineering Test
- Line-Of-Sight Multi-Purpose (LOS-MP)
 - Latest Tests Look Promising In PD & Air-Burst Mode
- M762A1 / M767A1 Electronic Time (ET) Artillery Fuze
 - 53 Consecutive Successful Lots (Since Production Started 2001)
 - » 99.7% Overall Reliability
- Excalibur S&A and HOB Sensor
- Enhanced Portable Inductive Artillery Fuze Setter (EPIAFS)
 - In Support of Excalibur (Integration Into PEFCS)
- M734A1 Multi-Option Fuze for Mortars
 - 99.46 % Overall Reliability (70 Consecutive Successful Lots)
- Advances In MEMS S&A Devices
- 40 mm Lethal and Non-Lethal Proximity Demonstrations





Excalibur



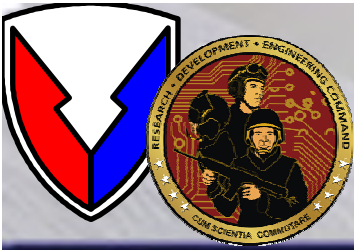


Fuze Development Center



- ❖ Provides Rapid Response to User and Customers
 - Fabricate and Test Under One Roof
 - Acquisition of Material / Parts Blanket Purchase Agreements
 - Continuous Investment in Facilities Maintains Relevance to New Technologies
- ❖ Facilitates Government/Contractor joint efforts.
 - Structured Data, Document, and Process Development Allows for Rapid Handoff To Production Vendor
- ❖ Programs Already Benefiting From The Facility:
 - 40mm Lethal and Non-Lethal Proximity Fuze
 - Excalibur Sub-Assembly Testing
 - Marine Corp PIAFS Training Kit
- ❖ Future Programs:
 - Mortar Mission Setter.
 - Enhanced Active Protection System (EAPS)
 - FTI Efforts





ARDEC In-House Fuzing Capabilities



- Engineering Modeling and Simulation
- Electromagnetic Environmental Effects (E³)
- Armament Technology Facility
- Centrifuge Capabilities
- Air Gun / Rail Gun
- Environmental Conditioning
- ARDEC Soft Recovery System (SRS) Facility
 - 155 mm Soft Catch (Scat) Gun
 - » 39 – 62 Cal Capability
- Fuze Development Center

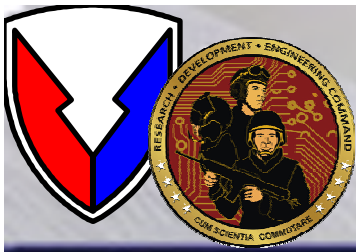


Armament Technology Facility



Soft Recovery System Facility





Defense Ordnance Technology Consortium (DOTC)



Mission: Provide rapid transition of new lethality and protection technology

DoD Ordnance Laboratory Center

- DoD, DoE, Other Agencies and Departments

National Warheads and Energetics Consortium

- Contractors, Academia, Not-for-profit/Non-profit Organizations
- 67 Consortium Member Agreements (CMA) with industry and academia
- Members partner in submitting project proposals
- Members May Offer cost sharing in their project proposals

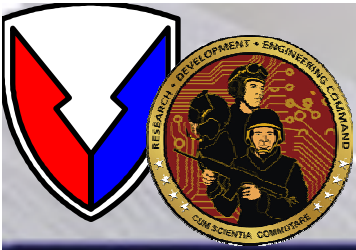
...Partnering to leverage investment and capability

- Utilizing Other Transaction Agreements (OTA) – Section 485
- Leading to: Task Order Sub-Agreements (TOSA), CRADAs, DEAs

FY06 Funded Projects (Fuze Area)

- Micro Fabrication R&D
- Foundry Services
- Proximity Fuze R&D
- Fuze Integration
- Fuze Prototyping
- Sensor Development
- Battery/Energy Development





ARDEC Overview Summary



- **Fuze Division Mission Spans Total Fuze Life Cycle**
- **Full Breadth of Munition Product Lines:**
 - **Artillery, Mortars, Tank, Medium / Small Cal,**
 - **Missiles & Rockets, Networked Munitions,**
 - **Mines & Demo, Non-Lethal**
- **Recent Technology Investments:**
 - **Advances Battlefield Capabilities**
 - **Puts ARDEC In Best Position To Support Warfighter**

**Fuzing Is At The Forefront Of
Safety & Lethality**

NDIA 50th Annual Fuze Conference UNITED STATES NAVY OVERVIEW

Stephen Mitchell
Co-Chair, Naval Energetics Enterprise

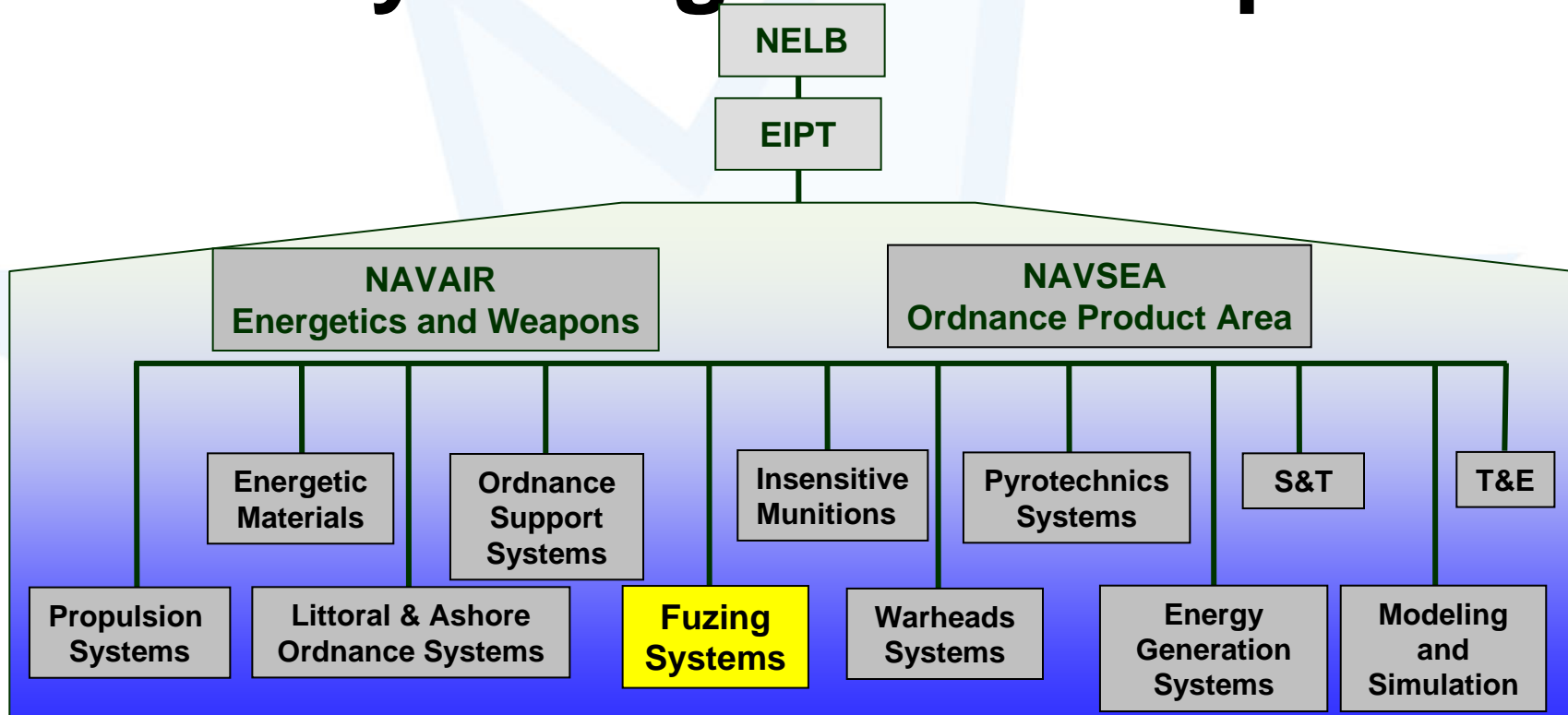


OUTLINE

- **Navy Energetics Enterprise – NEE**
- **Navy Safety Board Structure**
- **Air, Surface, Undersea Navy Programs**
- **Emerging Technology**
- **Summary**



Navy Energetics Enterprise

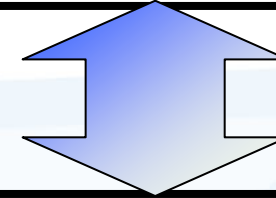
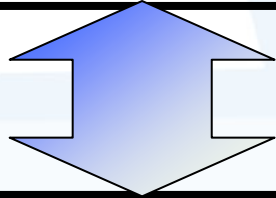


- Collaboration to provide best technical solutions for Warfighter needs
- Achieve long-term cost avoidance resulting from shared people and facilities

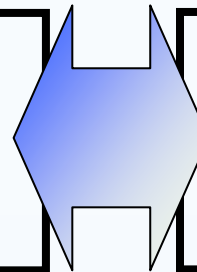


Navy Fuze Safety Review Process

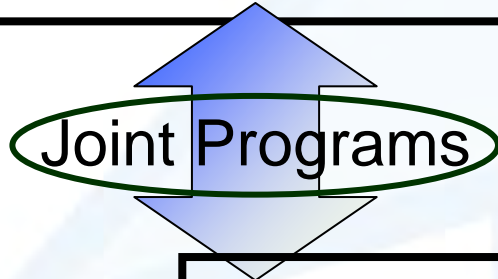
Weapon System Explosives Safety Review Board – WSESRB



Fuze Initiator System
Technical Review Panel
FISTRP



Software System Safety
Technical Review Panel
SSSTRP



Joint Programs

Army Fuze Safety Review Board

AF Non Nuclear Weapons Safety
Board



Fuze Initiator System Technical Review Panel FISTRP

Panel Chair – Jack Waller

Panel Members – Ralph Balestieri
Randy Cope
John Hendershot
Dave Libbon
Dave Riggs
Brian Will
Ray Ash

Tinya Coles-Cieply
Brad Hanna
George Hennings
Scott Pomeroy
Gabe Soto
John Kandell
Gene Marquis

Current Topics of Interest/Challenge

- **Evolving Requirements Definition (within FESWG)**
- **Move to STANAGS**
- **1901A/23659B – In-Line Ignition Safety Device (ISD)**
- **Programmable Logic Devices (PLD) Implementation**
- **Built In Test (BIT)**





FMU-139 Family Electronic Bomb Fuze



- **FMU-139C/B Currently Being Procured From KDI and ATK**
 - **Replenish Current Aging Inventory**
 - **Extended Operational Life With FFCS**





FMU-139 PIP Efforts



- **Currently Being Conducted at KDI and ATK**
 - **Enhanced Capabilities Demonstration**
 - **Serial Data Interface**
 - **Increased Penetration**
 - **In-Line Explosive Train**
 - **Increased Reliability**

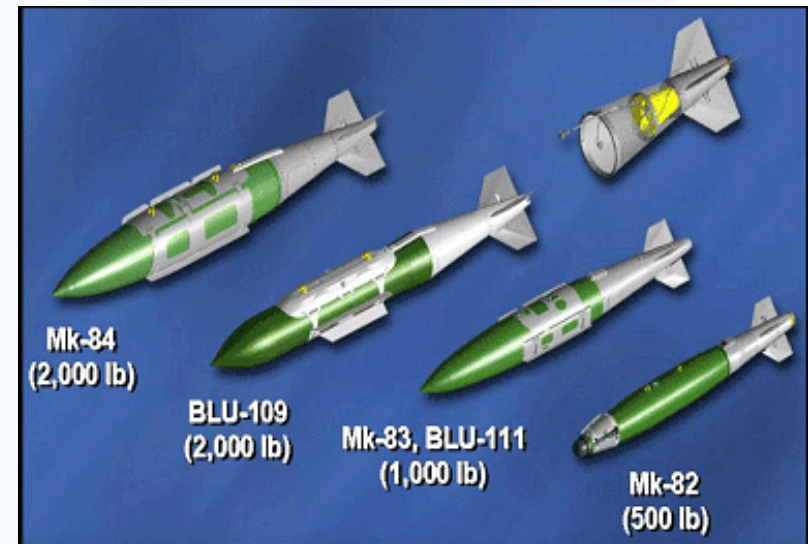




FMU-139D/B



- Next Version of FMU-139
 - ✓ Enhanced Capability
 - ✓ Enhanced Reliability



**Planned Full & Open Competition
RFP Release Late FY-06**





HI-REL FUZE

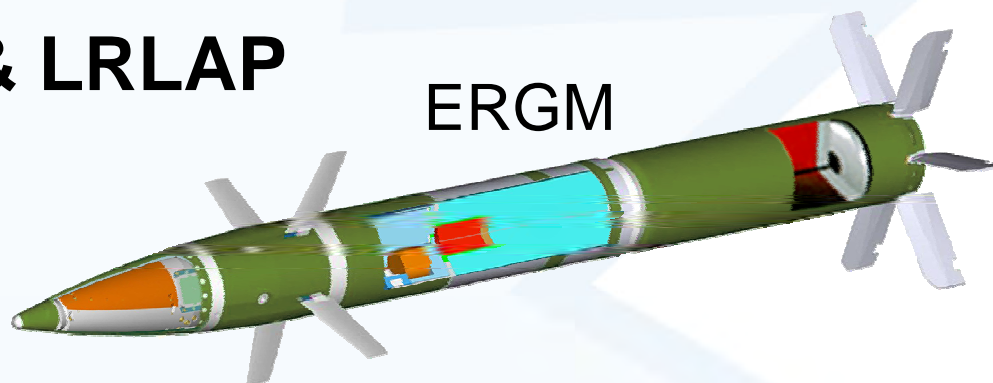
- Next Generation Fuze For Precision Guided Munitions
 - Dual Mode LGB, JDAM
- Higher Reliability
 - Eliminate external devices such as Fuze Function Control Set (FFCS), Mk-122 Arming System Switch, M 70 Series Cable, and associated electrical and mechanical connections (i.e. lanyard)
 - Incorporate Pre-Release Checks
- Safety Architecture Integral With MIL-STD-1760 Interface and Weapon Guidance Control Unit
- NAWCWD Conducting Tests to Evaluate Compliance of Approach with MIL-STD-1316





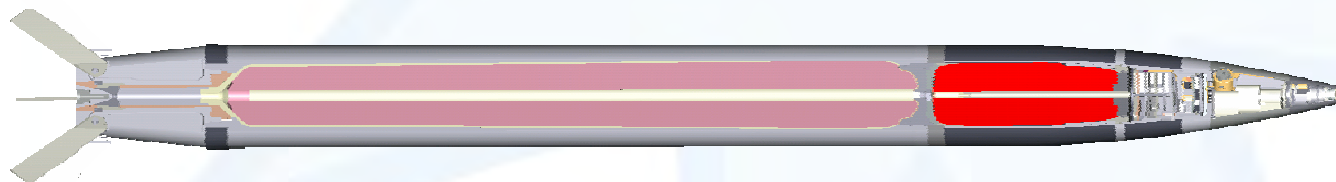
Gunnery Programs

- Long Range Guided Projectiles in Development:
 - ERGM, BTERM, & LRLAP
 - 41nmi+

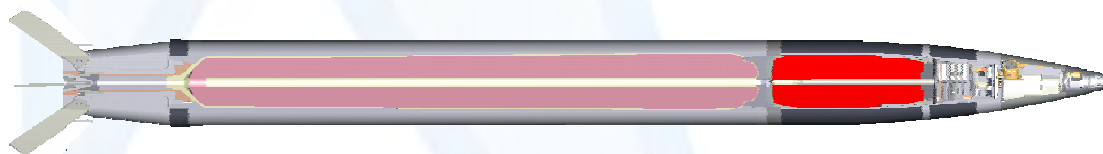


ERGM

LRLAP



BTERM



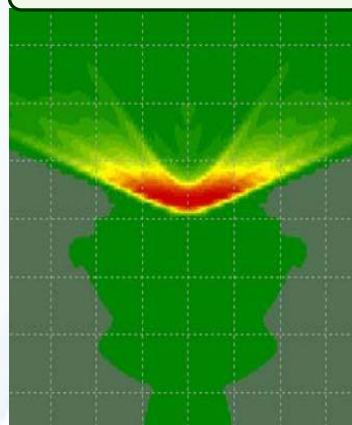


Gunnery Programs

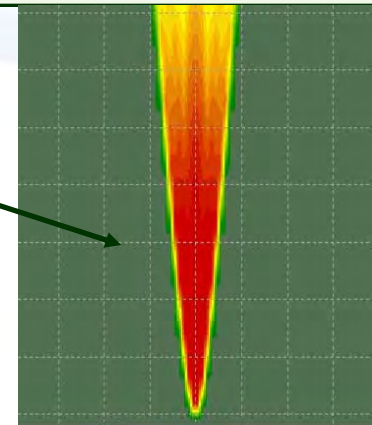
- **Short Range Self-Defense Projectiles:**
 - **5" Guns Have 3 New Projectiles: KE-ET, HE-ET, HE-MFF**
- **Minor/Medium Caliber Guns**
 - 25mm
 - 30mm
 - 57mm
 - 76mm



Existing HIFRAG



Shotgun Projectile



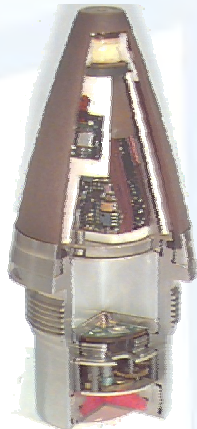
*Twice
the
Lethal
Area*



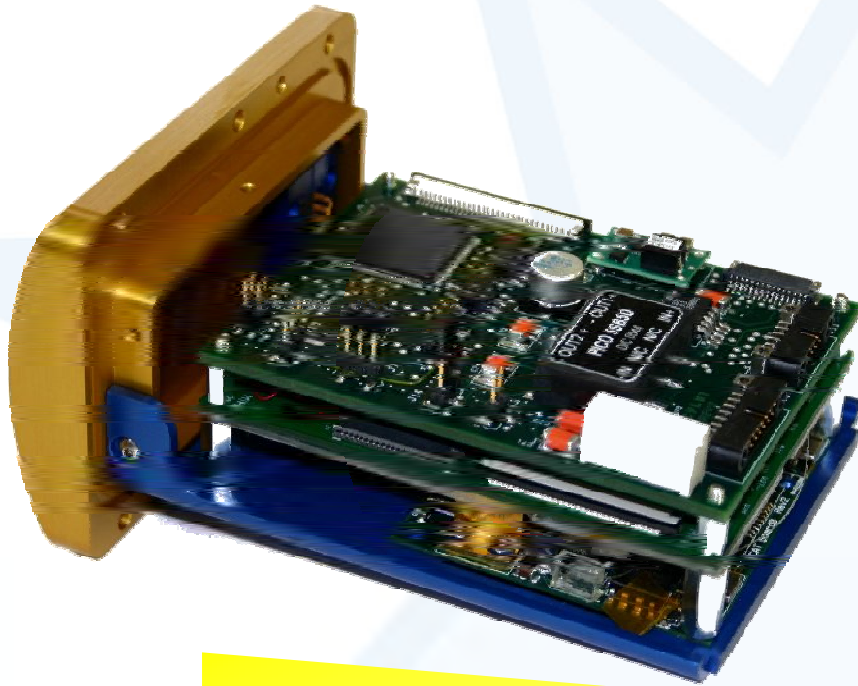


Gunnery Fuze Production Programs

- **Low Cost Fuzing**
 - **MOFN Instead of MFF for Most Threat Scenarios**
- **Producible Fuzing:**
 - **Need Battery for Next Production of MFF**
 - **Testing Diehl/Eagle Picher Batteries**



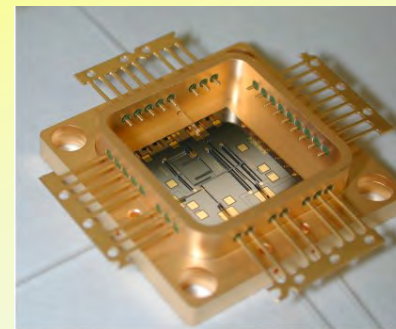
Future Undersea Weapon S&A



- **Multi-Mission Capable**
 - Single S&A configuration for multiple missions & platforms
 - Multi-point warhead initiation
- **Safety Features**
 - IMU based Safe Separation System
 - Safe-arm indication, safing switch

MEMS S&A package

- Miniaturization of safety and arming and initiation components
- Enables common S&A for multiple platform deployment
- Ruggedness demonstrated in harsh environments



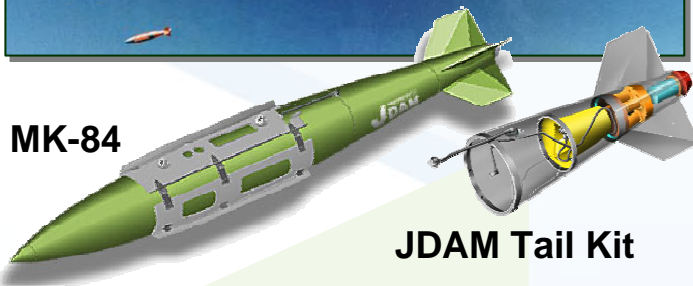
**Packaged MEMS
S&A Chip**



JDAM Assault Breach System JABS



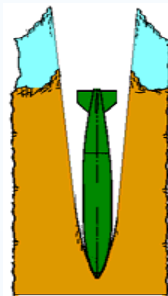
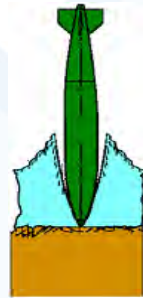
MK-84



JDAM Tail Kit

FY06 JABS S&T

- Flight tests with instrumented Fuzes
- Record water impact signature
- Monitor response of (FMU139) impact switches



- Fuze (FMU139) with pre-selected delay times to increase bomb effectiveness against mines / obstacles in the surf zone

- Bomb detonates at optimum position in range of water depths
- Increase lethality against mines and obstacles

- FY07 Evaluate JABS lethality in the Very Shallow Water (VSW)

Shock Hardened Recorder Redundancy

- Two Recorders per Bomb
- Two Accelerometers per Recorder
- Non-Volatile Memory

Data Recorder



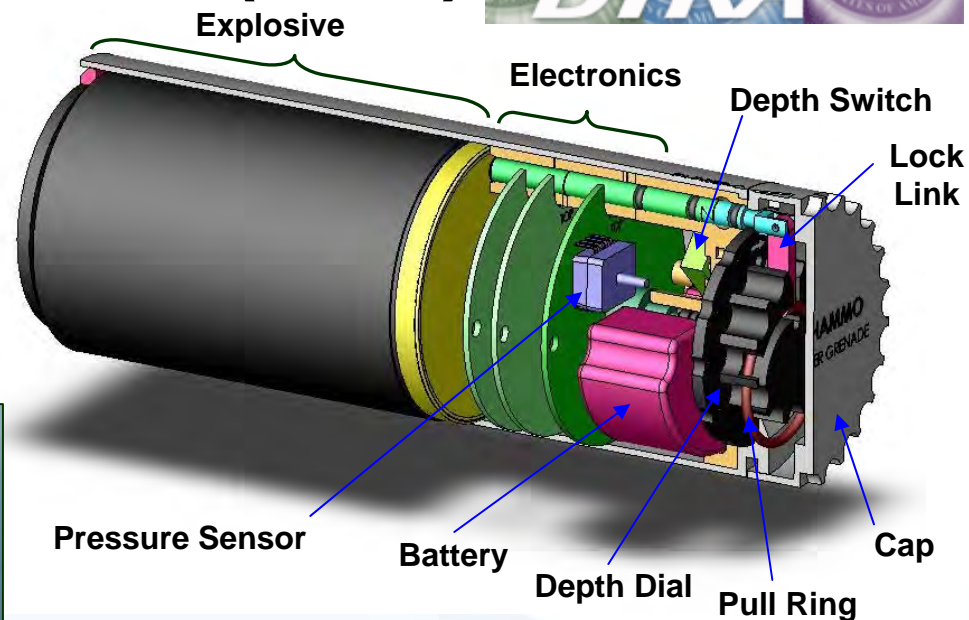
ANTI-SWIMMER GRENADE (ASG)



Force Protection



- Designed to protect assets from attack by SCUBA swimmers



Safety

- ASG will detonate only underwater beneath a predefined safety depth
- Will harmlessly render itself safe if it is activated but fails to see the correct arming environments

Features

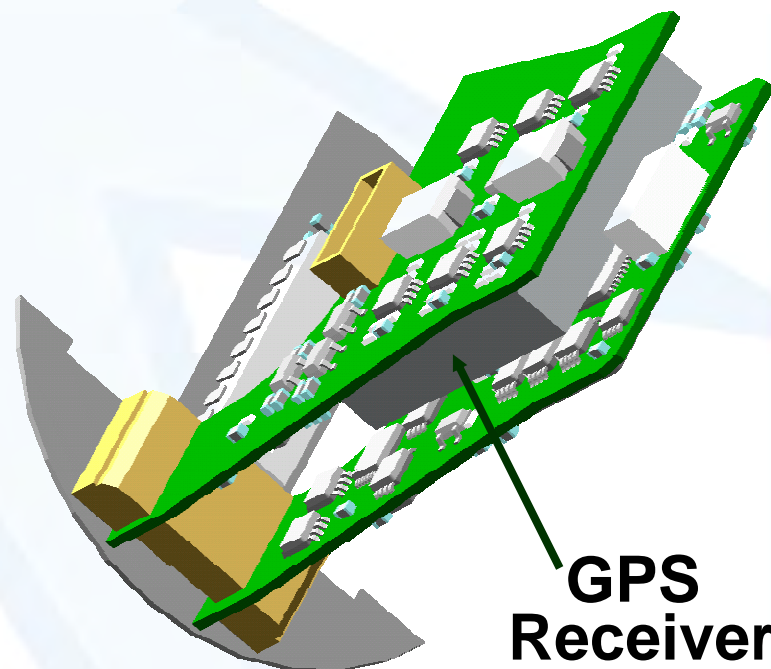
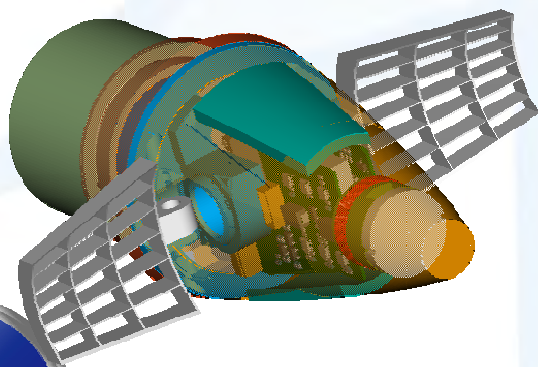
- Electronic In-Line Safe-Arm Device
- Hand-Emplaced Ordnance design meets MIL-STD-1911
- User-selectable function depth (10-ft to 100-ft in 10-ft increments)





Gunnery Technology Fuzing Thrusts

- **Low Cost Guidance:**
 - **GIF & PGK**
 - **Developing Next Generation GPS Receiver**
 - **Small Size (<1.5 in²)**
 - **Low Cost (<\$500)**
 - **Low Power (<1 Watt)**



ONR Future Naval Capability (FNC) Program

IMU Based Safe Separation System



- Miniature (MEMS based) Inertial Measurement Unit (IMU) embedded in S&A to measure safe separation distance
- Flexible IMU-based safety algorithm that incorporates:
 - Weapon post-launch position determination independent of guidance system
 - Two independent parallel algorithms for fault tolerance
- COTS IMU sensor integrated into S&A
- FY06: in-water tests of IMU sensors



ONR Discovery & Invention (D&I) S&T Program

MEMS S&A Technology



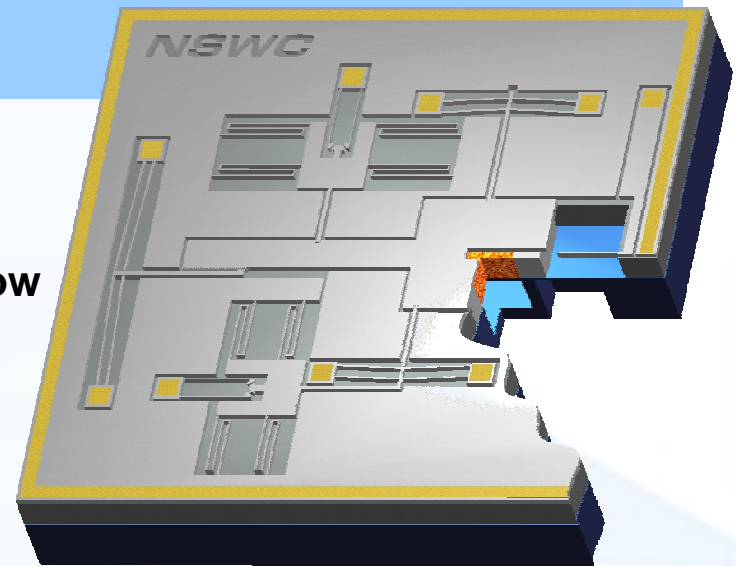
- Capitalizes on commercially available IC large scale batch fabrication techniques
- Enables weapon system integrated fuzing for multi-mission and scaled effect capability
- Reduces fuze cost and size

Status;

Completed characterization of 1st prototype S&A components and devices in laboratory ... long throw actuators, G sense locks & impact sensors

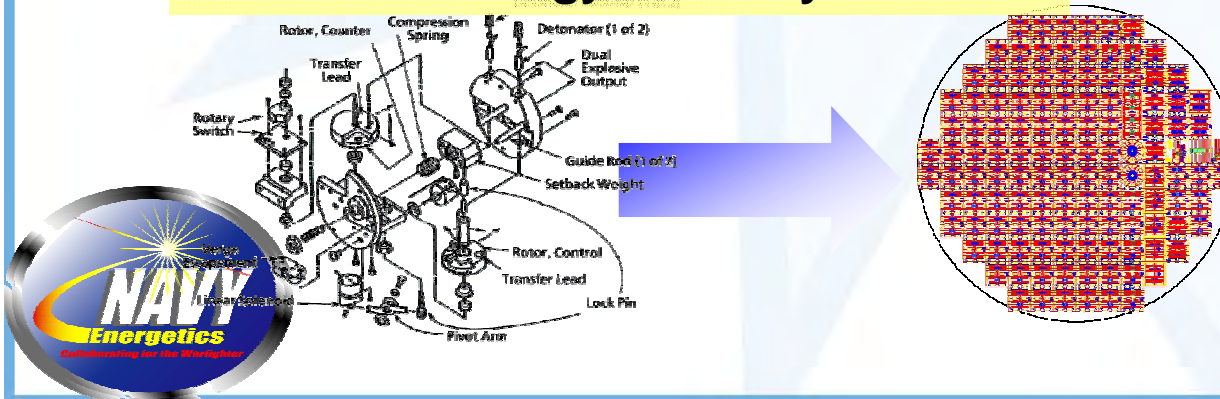
Designed & fabricated hermetic cap chips

MEMS in-situ detonator based S&A device technology currently TRL 4



S&A Chip

From tens of mechanical parts per fuze to 100's of fuze chips per single wafer



ONR Discovery & Invention (D&I) Program

In-Situ Micro Detonator Technology



- Energetics formed in-situ after MEMS fabrication
- No energetic waste material
- No processing equipment exposed to energetics

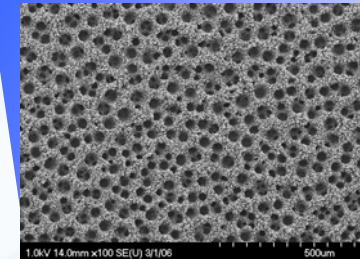
Status;

Developed in-situ (dry) conversion process

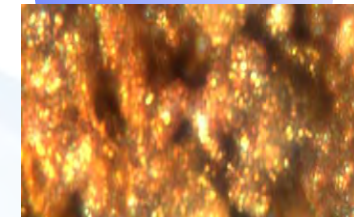
Demonstrated explosive transfer to qualified booster materials; RSI-007, PBX-N5 & Comp A-5

Currently conducting detonation characterization experiments

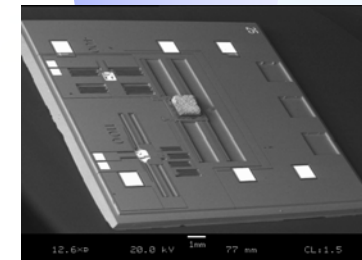
MEMS in-situ micro detonator technology currently TRL 4



Porous Metal



Azide Explosive



S&A Device with Micro Explosive



Summary

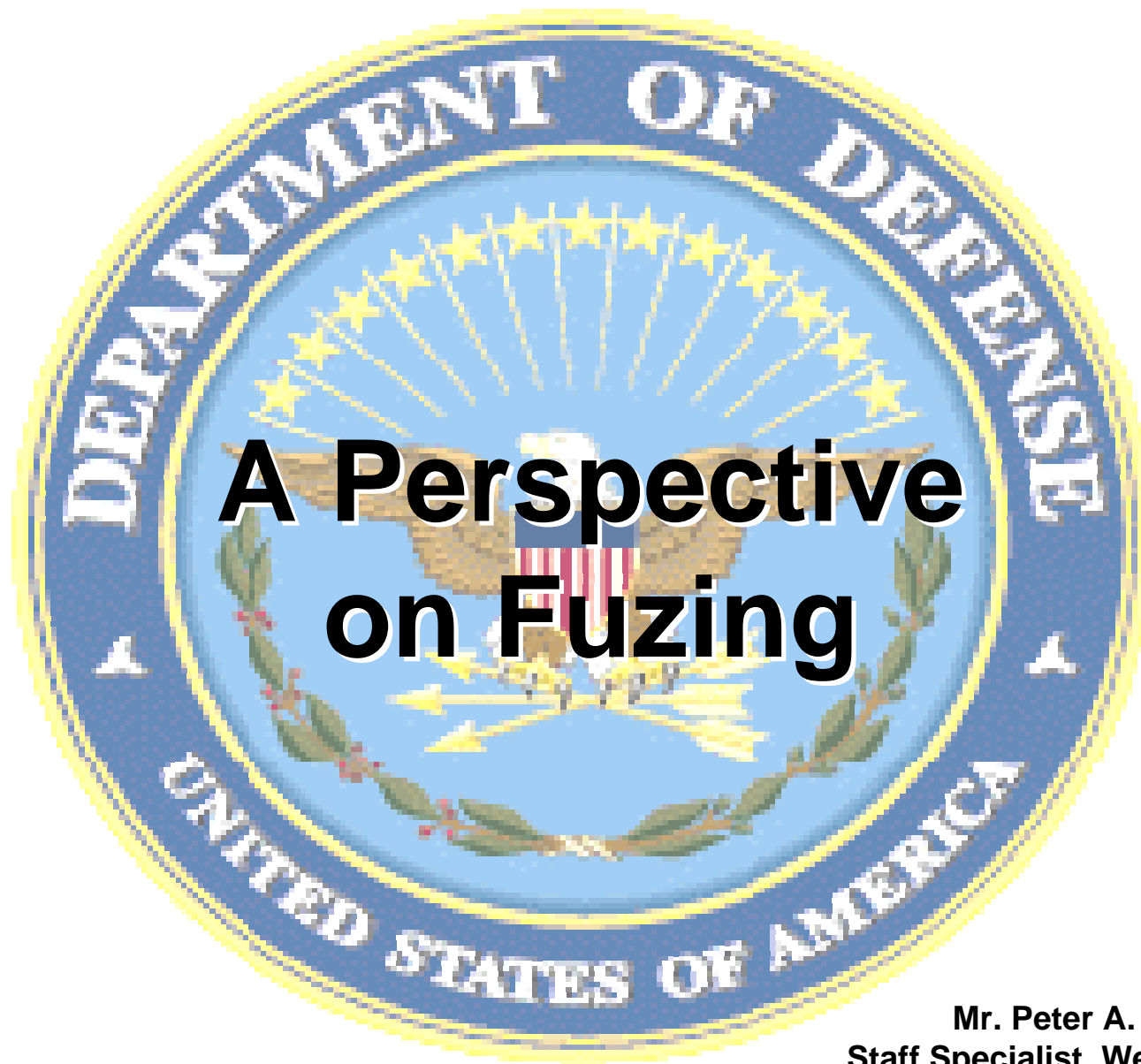
The Path Forward ...

Joint Fuze Technology Program

- Navy PM/PEO community validated weapon requirements and needs that fed into the Joint Fuze Technology Program (DoD Fuze IPT)
 - Joint Fuze Technology Program will leverage on Navy S&T efforts and advancements
- Examples of Navy Future Capabilities Needed
 - Hard and Deeply Buried Target Fuzing
 - Increased reliability to reduce UXO
 - Multi-mission selectable fuzing
 - Advanced initiation for controlling lethal effects

Navy Energetic Enterprise





A Perspective on Fuzing

**NDIA 50th Annual Fuze Conference
May 9, 2006
Norfolk Waterside Marriott,
Norfolk, VA May 9 - 11, 2006**

**Mr. Peter A. Morrison
Staff Specialist, Weapons Systems
OUSD/DDR&E/S&T/WS
peter.morrison@osd.mil
(703)588-7432**



S&T Mission

To ensure that warfighters
today and tomorrow
have superior and
affordable technology to
support their missions
and to give them
revolutionary war-
winning capabilities.





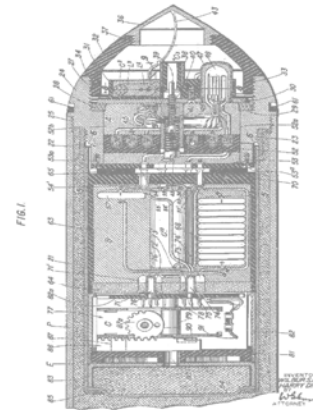
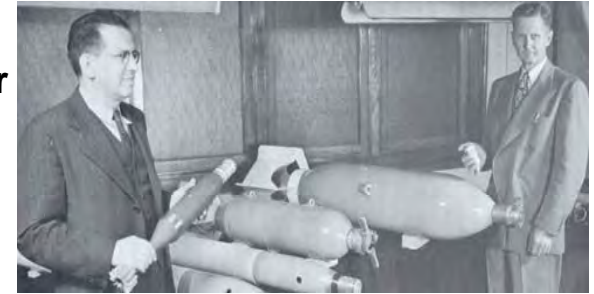
A Historical Perspective on Adaptation to Needs

Proximity Fuze Development and Production in WWII

Problem: Early in WWII, Proximity (VT) fuzes were prohibitively expensive, low performance and unreliable to counter air targets or ground targets with optimum effects at height above the ground.

Development:

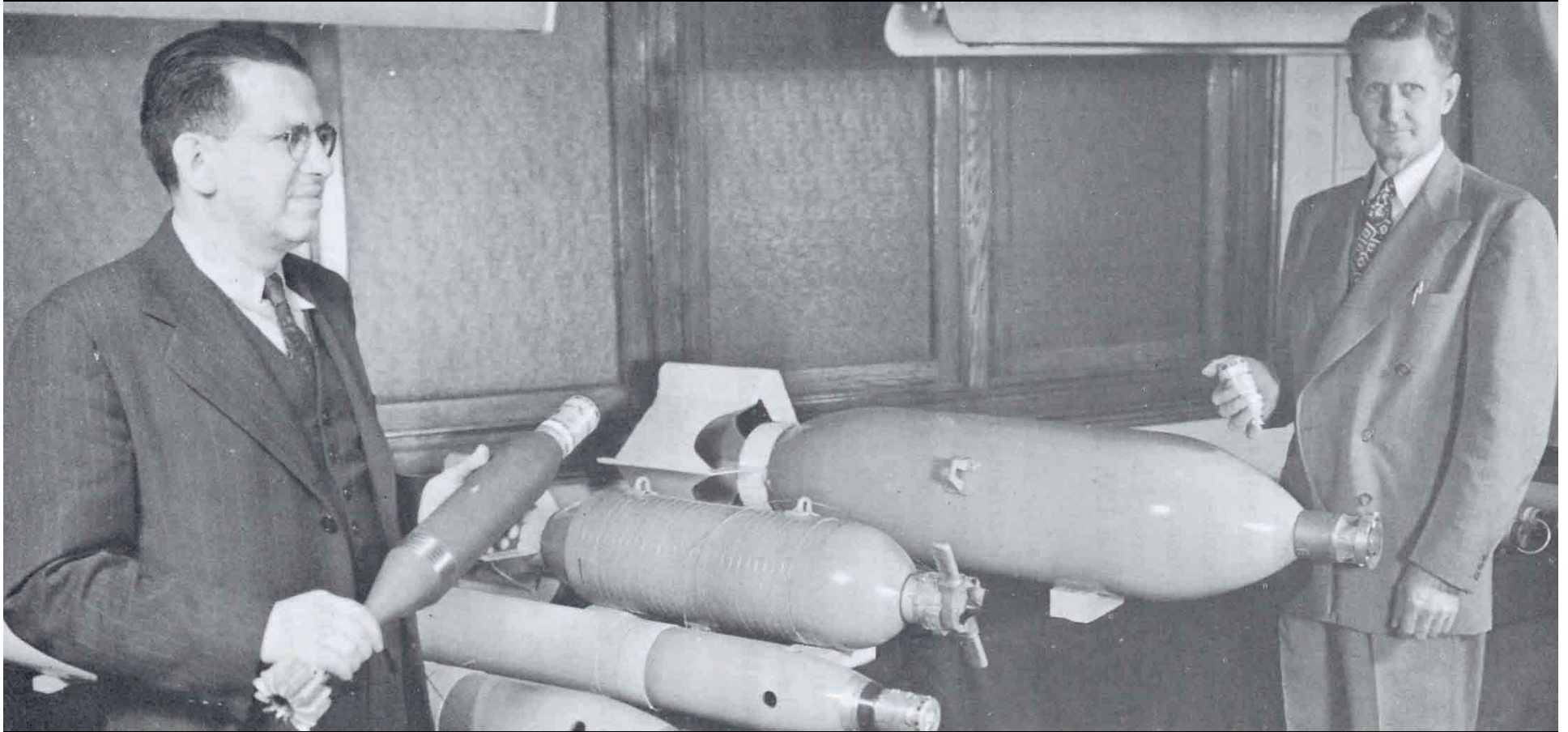
- ▶ Development of proximity fuzes started in the summer of 1940
- ▶ The development effort involved an estimated number of at least 2,236 individuals
 - Efforts began at the National Defense Research Committee (NDRC) and Office of Scientific Research and Development (OSRD)
 - Two different developmental teams were made up of individuals from the Department of Terrestrial Magnetism, National Bureau of Standards, Johns Hopkins Applied Physics Laboratory, Military, academia
 - Initially, Civilian Scientists from the National Bureau of Standards (NBS) under the leadership of Harry Diamond were recruited and this work later transitioned to the US Army for various weapons systems
- ▶ Labor costs, from records, were estimated at approximately **\$837,000,000** (2002 dollars)
- ▶ The War Department later described inventor Harry Diamond's proximity fuze as "one of the outstanding scientific developments of World War II ... second only to the atomic bomb" in military importance



Production:

▶ Actual costs per fuze was **reduced from \$732 in 1942 to \$18 in 1945**, permitting over **twenty-two million fuzes** to be purchased for about **\$8.5 billion (in 2002 dollars.)** In March of 1945 alone, there were approximately 110 companies engaged in the production of VT fuzes for spinning rounds, bombs, rockets and mortars

We know where we've been...



Where are we going?

9/11 Changed Everything

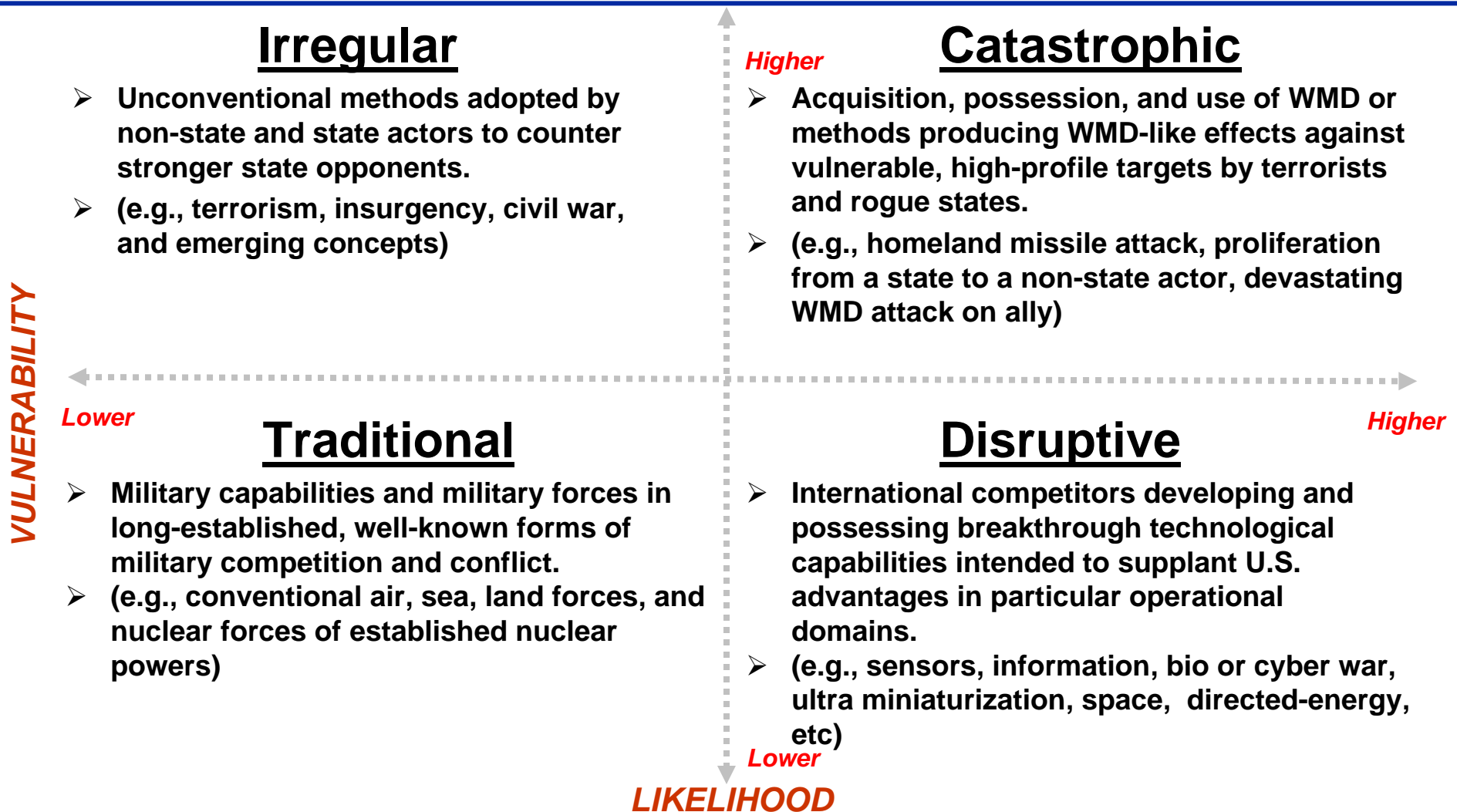
*From working to provide overmatching capability against any **nation-state** on the sea, in the air and on the land ... to a **global war on terrorism** against an enemy who fights in the shadows...*



“The concept of a virtual organization is essential to understanding how 21st Century business will work. Al Qaeda represents a new and dangerous kind of virtual organization and the rise of the virtual state. We are entering into an era in which a small number of people, operating without state sponsorship, but using the enormous power of modern computers, biogenetic pathogens, air transport, suitcase bombs, and even small nuclear weapons will be able to penetrate the tremendous vulnerabilities of contemporary open societies.” - *Time*, 9 Sept. 2002

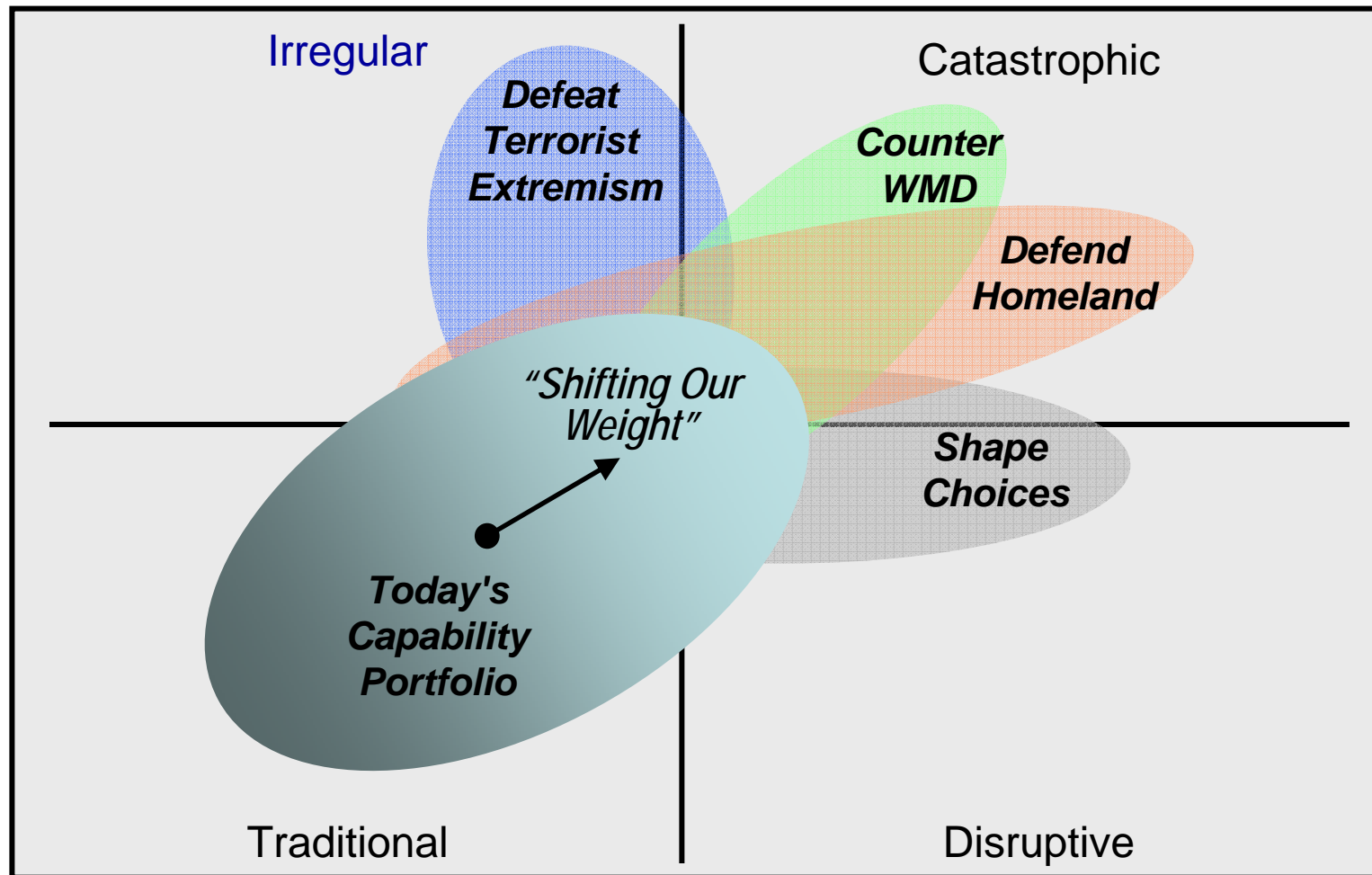
Changing Security Environment

- Four Challenges -



Uncertainty is the defining characteristic of today's strategic environment

QDR Re-balancing Future Force Capabilities



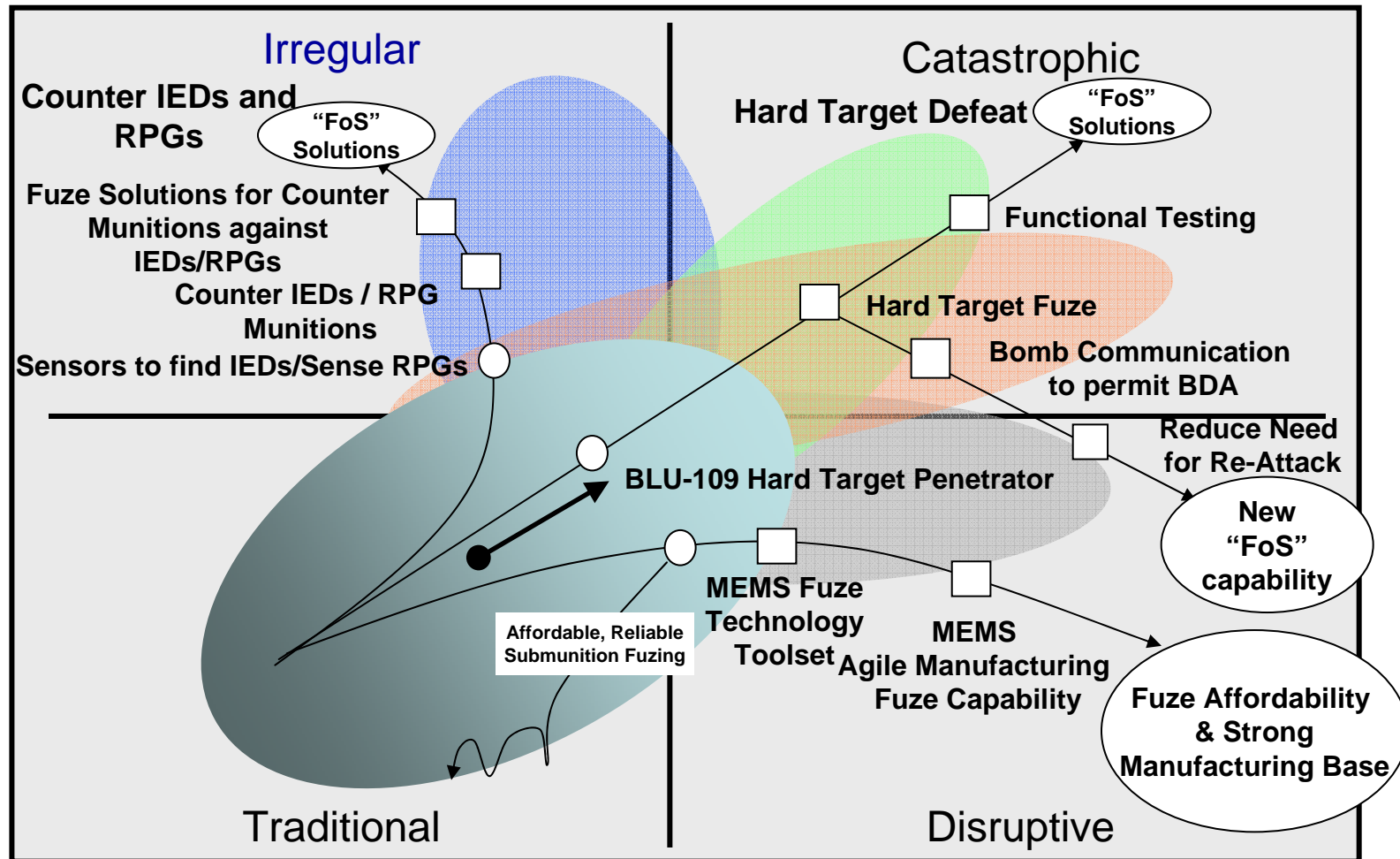
Continuing the reorientation of military capabilities and implementing enterprise-wide reforms to ensure structures and process support the President and the warfighter

QDR Re-balancing Future Force Capabilities:

A Suggested Path to Rebalance Fuzing Thrusts to Meet Future Capabilities



"Shifting Our Weight"





Munitions Procurement Trends

- ▶ **Affordability can not be ignored!**
- ▶ **Heavier emphasis being placed on Precision Munitions, Weapons for Autonomous Systems and Multi-Mission Weapons**
 - **Guidance systems increase munitions cost & Systems complexity**
 - **Can not afford to miss the hidden costs! (DOTMILPF*)**
- ▶ **Traditional munition inventories counts will be smaller and replenishment on use will be a “just in time” production issue**
- ▶ **Industrial Base will be affected:**
 - **Surge and Agility vs. Mass Produced Quantity Systems Approach**
 - **Requirements (such as IM) are driving AUR costs up**
 - ▶ **Will we be forced to buy Less?**
 - ▶ **Can we afford “Service requirements creep?” vs. Joint, Multi-Mission Roles**
 - **If fewer munitions are being bought, so mass production value is lowered: Cost goes up for start up, qualification.**
- ▶ **DoD perspective:**
 - **These issues will drive the acquisition cost of munitions systems**

**The Department cannot buy what it bought before,
and not at the same cost...**

** DOTMILPF, Doctrine, Organization, Training, Material, Leadership and Education, Personnel, and Facilities*

DoD Fuze Ongoing Status/Update



- ▶ **OSD AT&L LW&M, DDR&E S&T, and DUSD/IP in active participation**
- ▶ **Services – PEO's/PM's, Laboratories involved and active**
- ▶ **DOE – Weapons Laboratories, DOE-DoD Technical Coordination Groups (TCG)**
 - **Active and Sharing Information Openly, Transparently**
- ▶ **Teams:**
 - **Fuze Technology – Joint Service Fuze Technical Panel***
 - **Acquisition data collection survey and update***
 - **Industrial Base Survey* (DUSD/IP, DCMA Study concluding 2006)**
 - **Policy**

** Details contained in Brief "Fuze IPT Perspective," by **Mr. Lawrence Fan**, Fuze and Microsystem Project Manager, NSWC*



Conclusions

- ▶ **The Business Case has changed:**
 - Lower munitions procurement budget trends
 - Fewer fuzes are expected to be bought
 - Precision munitions are driving costs up and quantities down
 - New requirements will need to be met
 - Can not ignore other Cost Drivers (DOTMILPF)
- ▶ **The “shift” to Irregular, Disruptive and Catastrophic warfare is liable to change the focus or perspective of need for traditional munitions**
- ▶ **The proximity fuze was once heralded as one of the most significant technological accomplishments of WWII because it provided the “shift” that was needed at the time**
- ▶ **We need to be innovative, agile and adaptive to address changing threats and to meet requirements for modern munitions**

AIR FORCE FUZE TECHNOLOGY

10 May 2006



**Timothy Tobik
Branch Chief
Fuzes Branch
Munitions Directorate
Air Force Research Laboratory**



Outline



- **High Level Visibility**
- **Air Force Research Laboratory
Planning Process**
- **Program Status**



PEOs Publicly Summing Up Fuzing Need at a High Level



July 2005 Air Force Magazine –

“Holes in the Pipeline”

Asked where there are “holes” in the munitions pipeline, Chedister (Maj. Gen. Robert W. Chedister, Air Force program executive officer for weapons and commander of USAF’s Air Armament Center at Eglin AFB, Fla.) said more money is needed in the research end.

“So, some of us worry that we’re not working on the new technologies of the future that we need to be. On the top of that list is fuzes, Chedister said. . . . fuzes on hand are “**not smart enough, ... not rugged enough, ... not durable enough** at the price we’ve been paying for them, and we’re **not putting enough money into the R&D** of making them better.” This is the “biggest hole in the weapons world.”





Fuze Capability Enabler

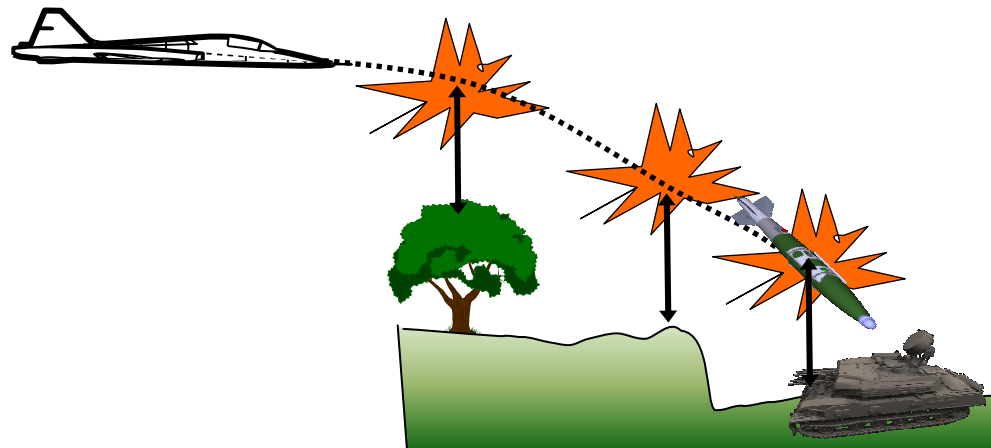
Example: Fuze Proximity Sensor



Inventory: DSU-33 B/B



- Single fixed height of burst
- 20 ft HOB
- Fuze on closest return
- Uni-Functional





Fuze Capability Enabler

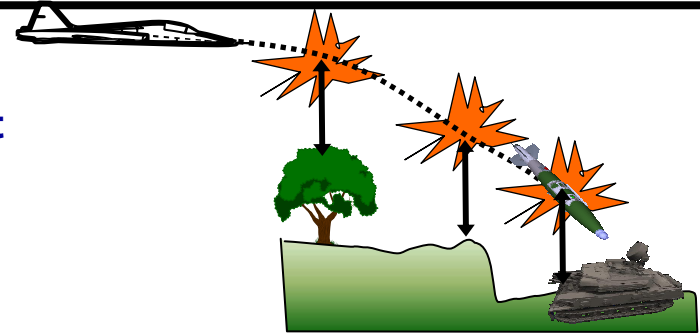
Example: Fuze Proximity Sensor



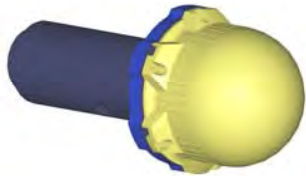
Inventory: DSU-33 B/B



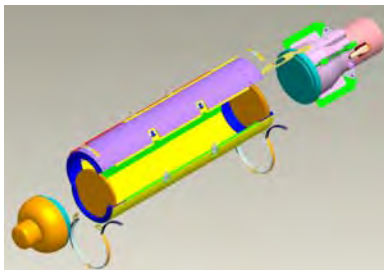
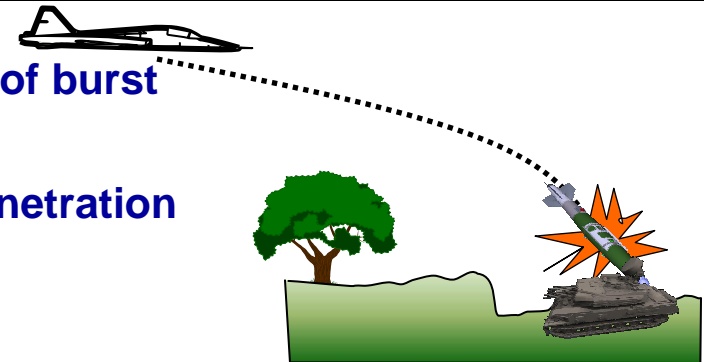
- Single fixed height of burst
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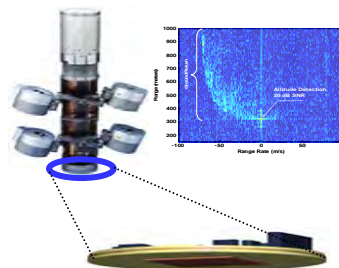
Fuze Air to Surface Technology (FAST)



- Electrically selectable height of burst
- 0 – 20 m @ 0.5 m increments
- Ground profiling & foliage penetration
- Extended range 20 – 3000 m
- Low cost digital components
- Expandable capability for receive



High Altitude Sensor



•Low Cost Altimeter for BLU-108



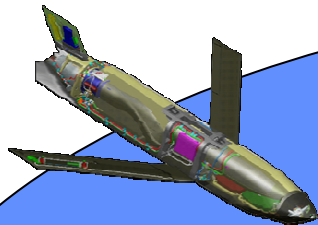
Link 16 Receive



Technology Focus



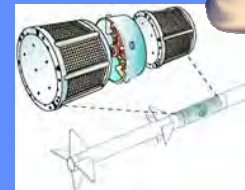
Battlespace
Access



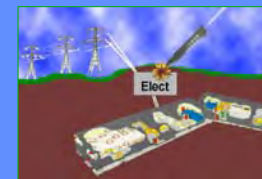
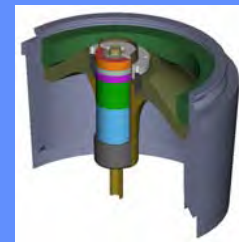
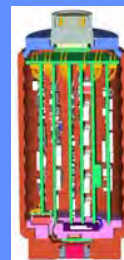
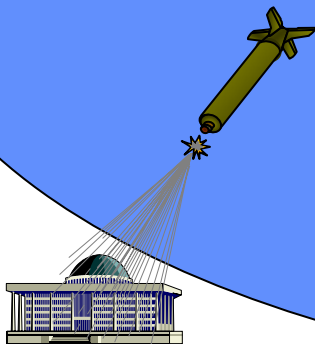
Area
Dominance



Air Supremacy



FUZZING TECHNOLOGY



Irregular/Catastrophic
Threat Neutralization

Revolutionary Technology

Facility Neutralization

Fuzzing is crucial to every Integrating Concept



Focused Long Term Challenges



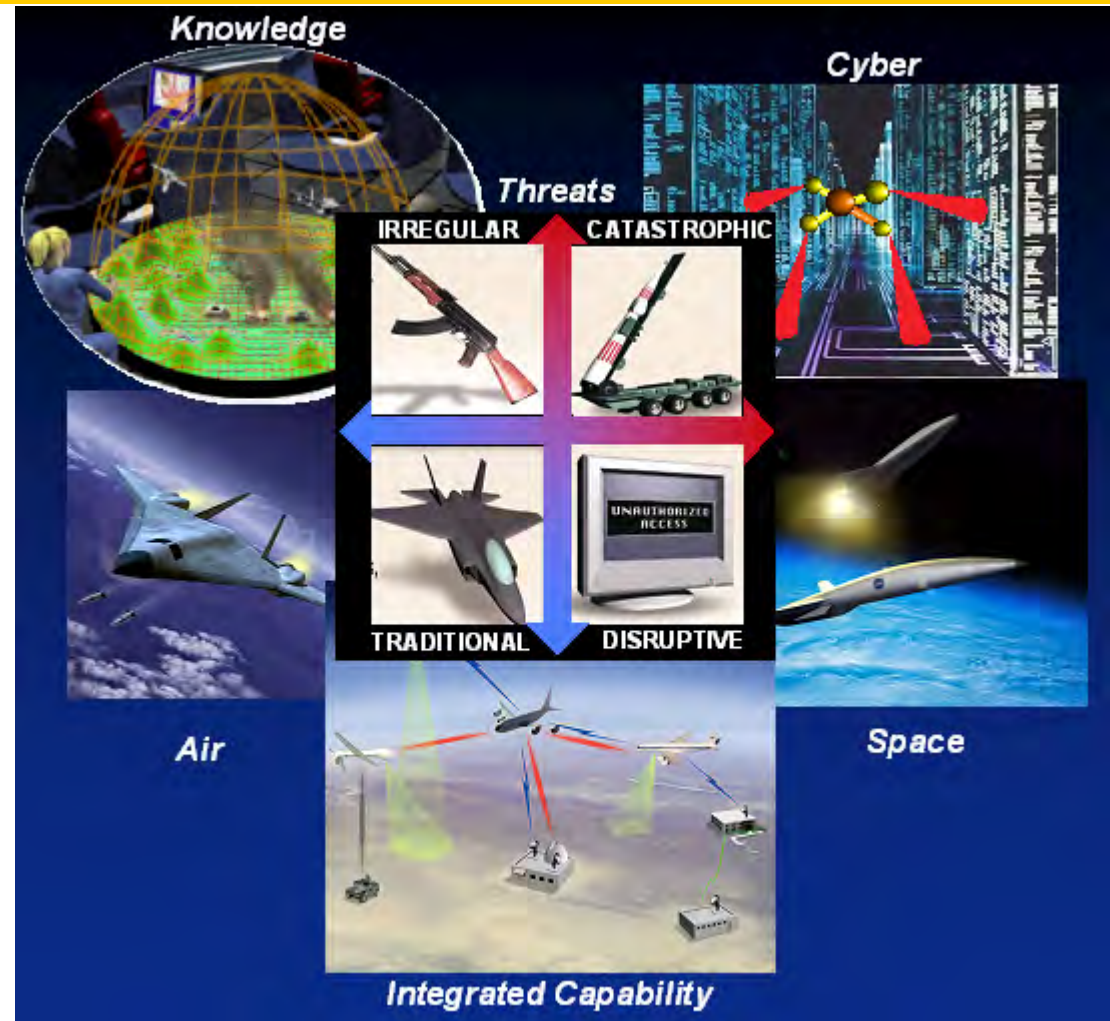


Focused Long Term Challenges



Delivering the Air Force S&T Vision Through Leadership, Discovery, Innovation, and Integration.

- Anticipatory Command, Control & Intelligence (C2I)
- Unprecedented Proactive Surveillance & Reconnaissance (S&R)
- Dominant Difficult Surface Target Engagement/Defeat
- Persistent & Responsive Precision Engagement
- Assured Operations in High Threat Environments
- Dominant Offensive Cyber Engagement
- On-demand Theater Force Projection, Anywhere
- Affordable Mission Generation & Sustainment



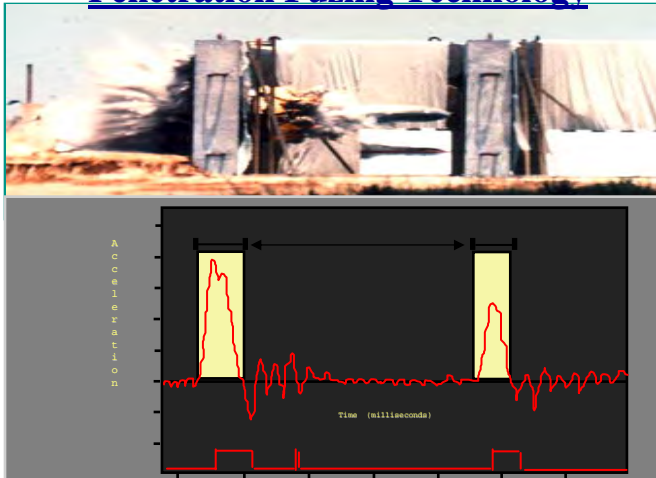


Fuze Challenges

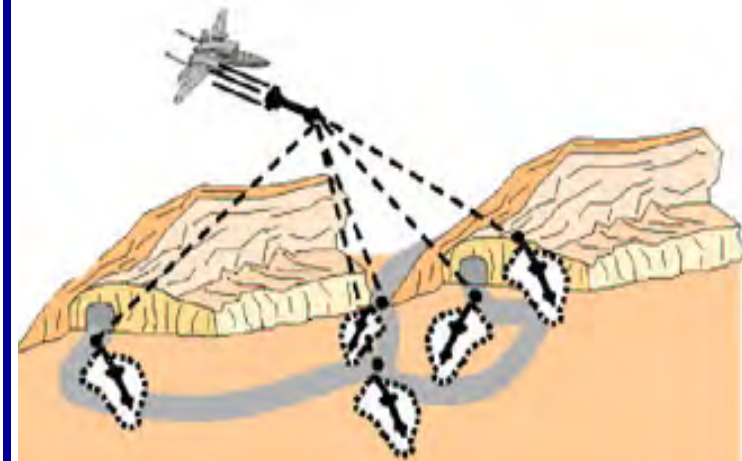


- **Penetration Fuzing**
 - Target Defeat
 - Target Denial

Penetration Fuzing Technology



Penetration Fuzing Technology





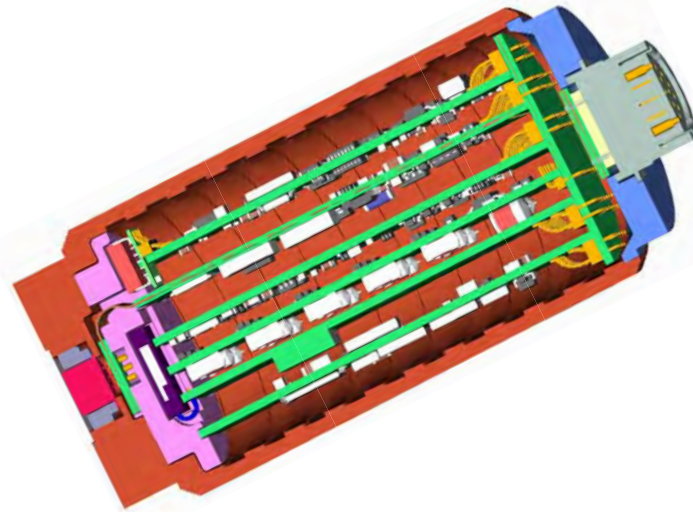
Survivable Thermostable Robust Intelligent Fuze (STRIFE)



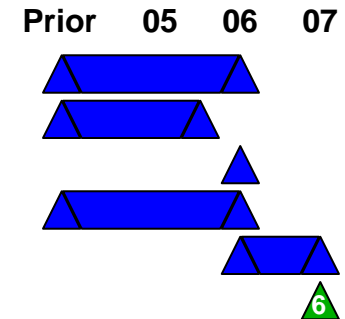
AFRL/MN

Munitions Directorate

Technology Investment Schedule (FY)



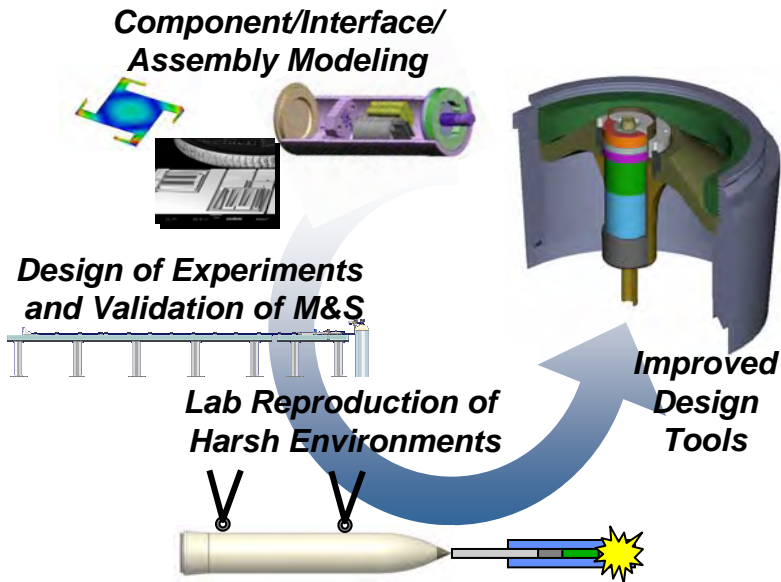
Phase I - Weapon/fuze interface mod.
Safety architecture/design mod.
Fuze fabrication
Phase II - Qualification analysis
Canon Test in relevant environment.
Fuzes provided to CAV for flight tests



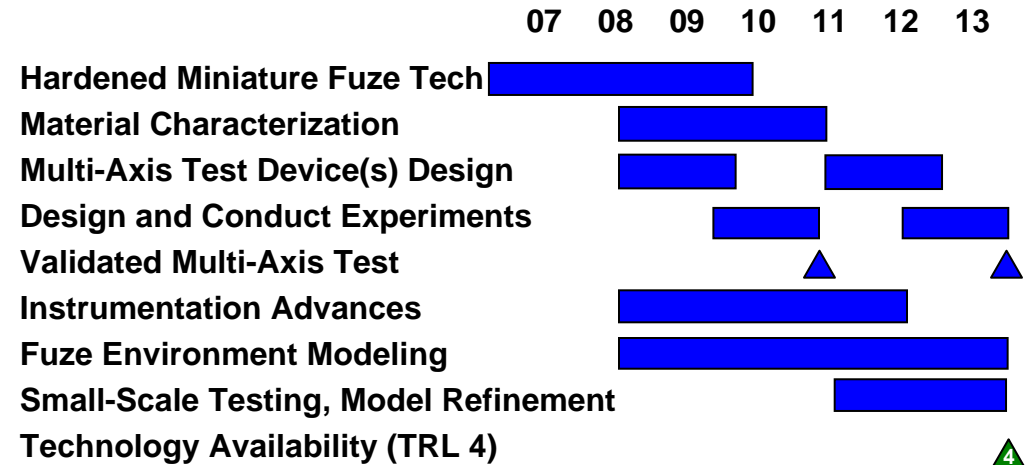
Description	Benefits to the Warfighter
<ul style="list-style-type: none"> • Provide interoperability between a smart fuze and the CAV flight vehicle. • Provide inert/live fuzes for the inert HSP 1000 sled test and MTD-3B/CAV flight test. 	<ul style="list-style-type: none"> • Ability to reach hardened and deeply buried targets which cannot currently be reached. • Fuze capable of surviving and functioning in the projected CAV environments. • Fuze capable of void, layer and depth of burial (DoB) modes of operation. • Design work will mature intelligent hard target fuzing.
Technology	
<ul style="list-style-type: none"> • Perform required fuze modifications for CAV integration <ul style="list-style-type: none"> • Development of weapon to fuze electrical interface design. • Development of safety architecture and detailed safety design for this unique weapon application. • Provide fuzes for inert HSP sled tests and live HSP sled and CAV flight demonstrations. 	



Harsh Environment Fuze Technology (HEFTY)



Technology Investment Schedule (FY)



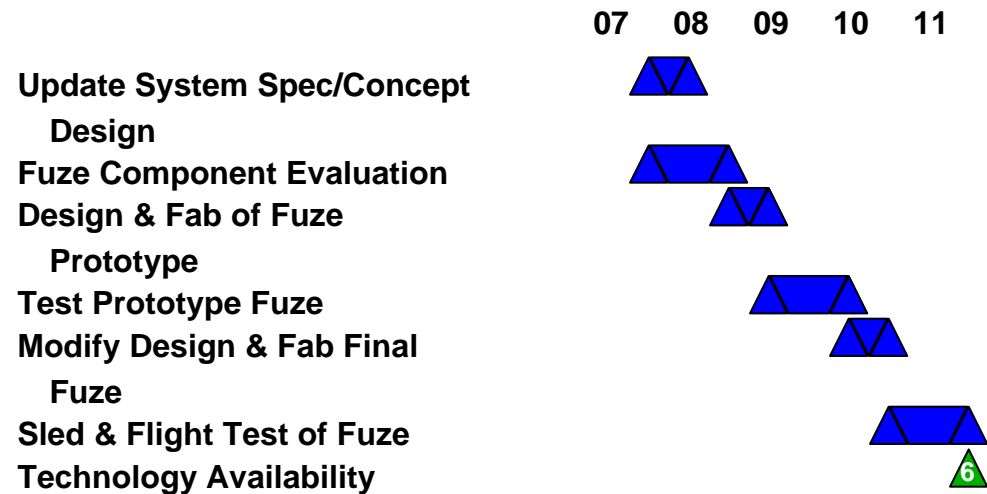
Description	Benefits to the War Fighter
<ul style="list-style-type: none"> Develop the capability to model, characterize, design, and test fuzes in relevant environments based on requirements for current and future munitions. 	<ul style="list-style-type: none"> Enhanced fuze reliability and performance in harsh environments of Global Strike weapons Increase Global Attack capability (Time Critical Targets) <ul style="list-style-type: none"> Hypersonic cruise missile High speed conventional ballistic missiles Hold high value, time-critical targets at risk
Technology	
<ul style="list-style-type: none"> Survivable fuze technology Microelectronics for harsh environments Validated M&S of fuze/well environment Model-based design of experiments Scaling of models for harsh environment prediction Dynamic test apparatus and methodology 	



Hard Target Influence Fuze (HTIF)



Technology Investment Schedule (FY)



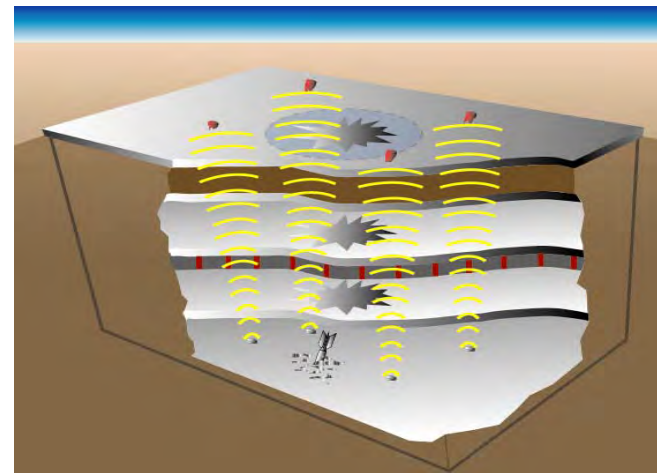
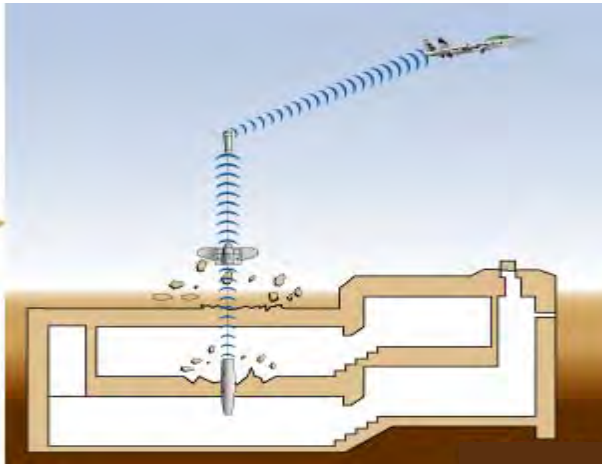
Description	Benefits to the Warfighter
<ul style="list-style-type: none"> Develop a fuze to provide active detection of vehicular traffic and deny/limit access to hardened and strategic targets such as tunnels, very deep / hard targets, WMD targets, mountain passes, and bridges Single fuze compatible with existing precision guided weapons Application for hard and soft terrain Future remote Command and Control features 	<ul style="list-style-type: none"> Highly shock survivable allowing for extreme delivery conditions Long-delay activation for functional denial Vehicle discrimination (programmable sensitivity) for increased safety Compatible with inventory weapons Compatible with existing guidance kits for precision delivery Application to hard and soft terrain Presidential Policy 30 compliant <ul style="list-style-type: none"> Humanitarian de-mining of anti-personnel landmines
Technology <ul style="list-style-type: none"> Shock hardened, cooperative seismic, acoustic and/or magnetic vehicle sensors Shock hardened, extended-life power source Target discrimination algorithm Shock hardened safe & arm and fuze electronics 	



Fuze Challenges



- Penetration Fuzing
 - Target Defeat
 - Target Denial
- Bomb Damage Sensing
 - Real-time bomb damage information from hard target weapon to airborne platform
 - Two way, shock hard, through earth communications

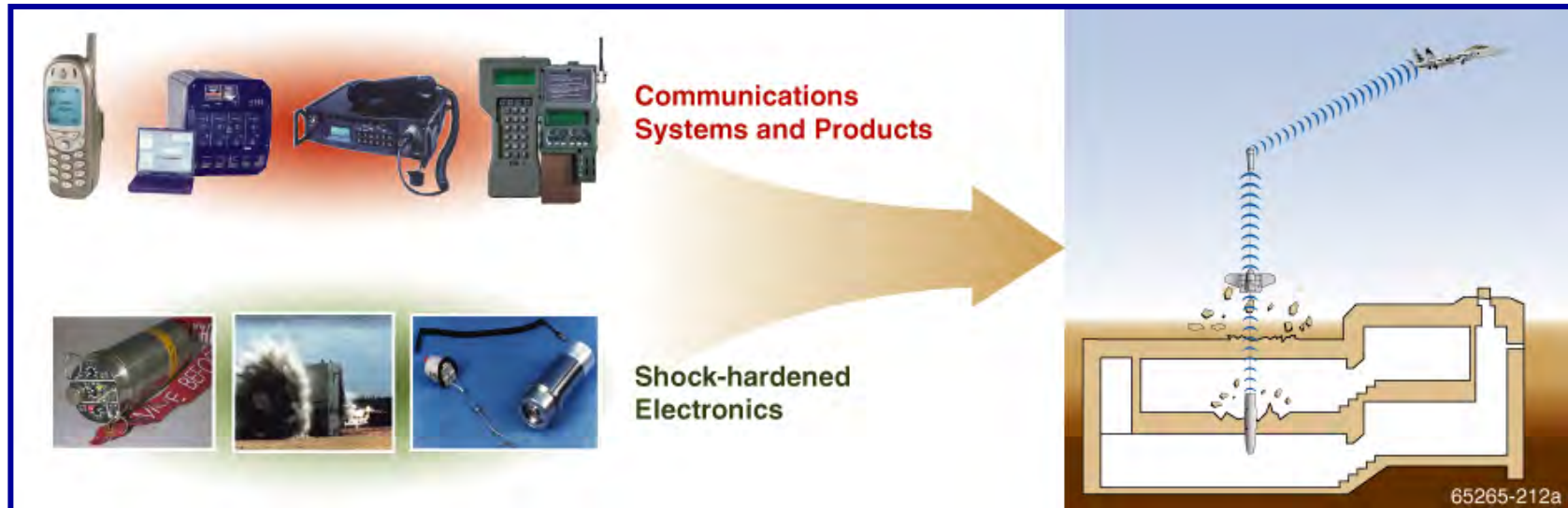




Fuze Integrated Bomb Damage Information Demonstration (FIBDID)

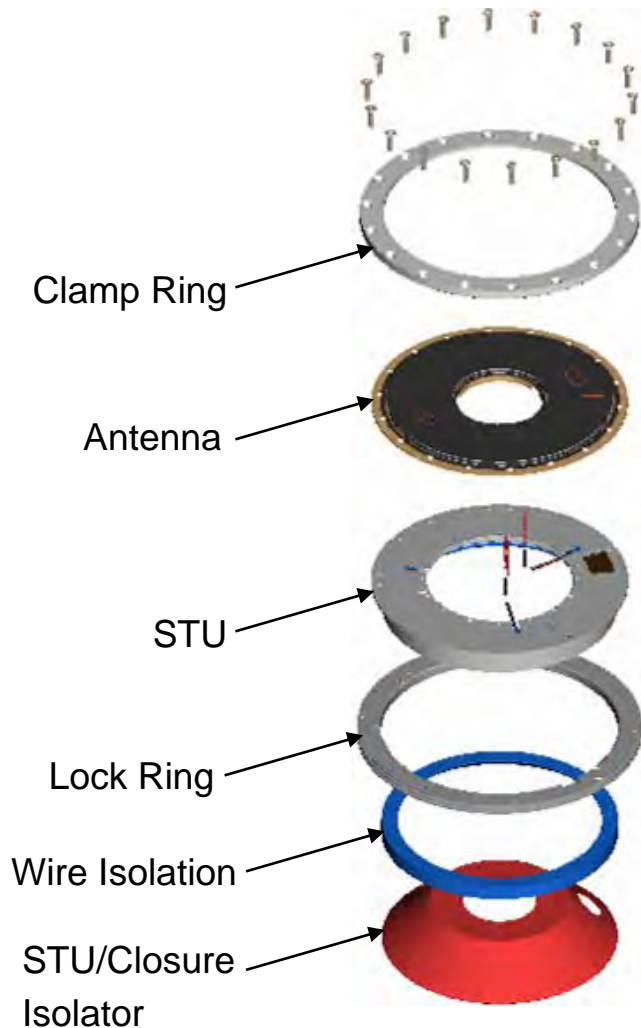


- Radio system that overcomes severe signal attenuation and distortion
- Hardware that operates as the weapon penetrates through hard target

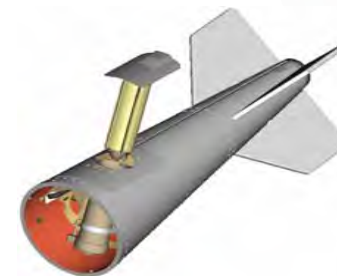
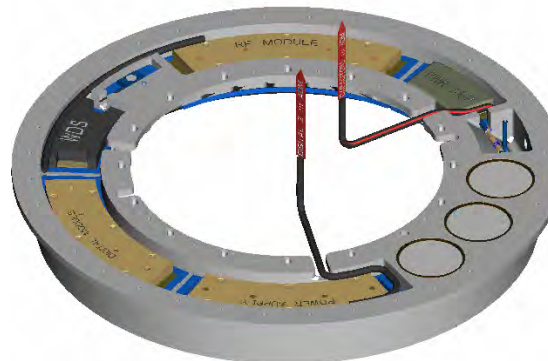




Key FIBDID Technologies



- **Shock Hardened BDI Electronics**
 - Shock hardening of hand-held radio transmitter
 - High losses in transmission through soil/concrete
 - Hardened accelerometer sensor module
- **Antenna Designs To Efficiently Couple RF to Soil**
 - Design limited by weapon size and space constraints
 - Requires shock hardening
- **Repeater Assembly & Deployment Design**
 - JDAM/BLU-109 and EGBU-27 deployment designs

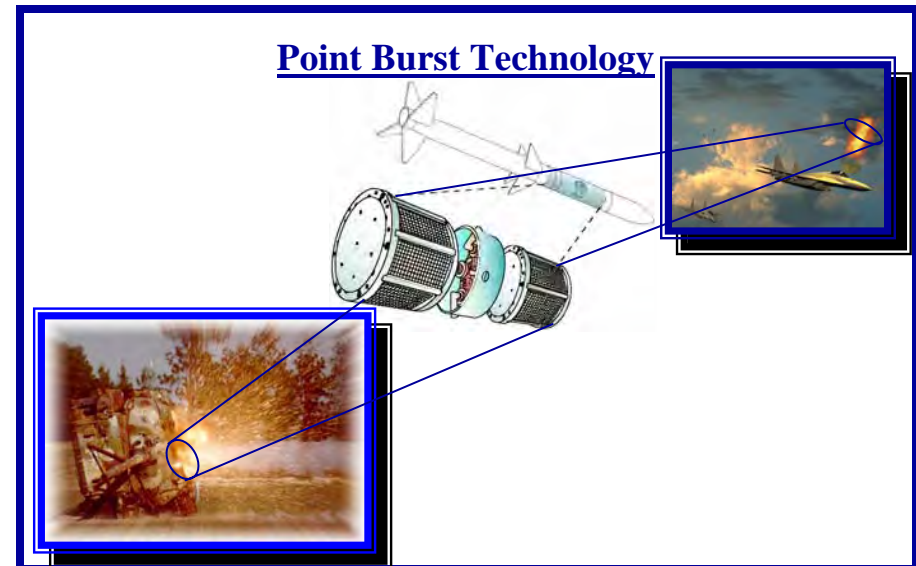
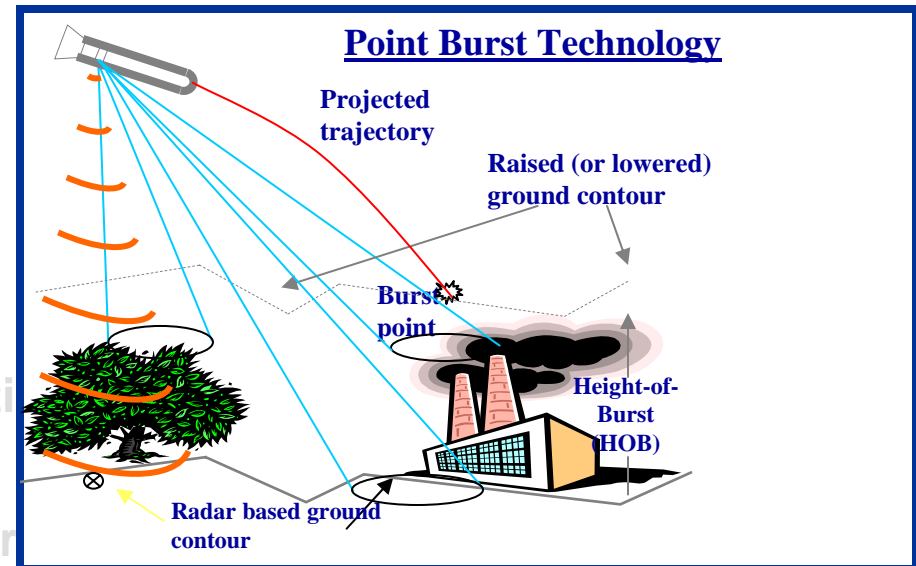




Fuze Challenges



- Penetration Fuzing
 - Target Defeat
 - Target Denial
- Bomb Damage Sensing
 - Real-time bomb damage information platform
 - Two way, shock hard, through ear
- Point Burst
 - Ground profiling radar
 - Active imaging fuze sensor





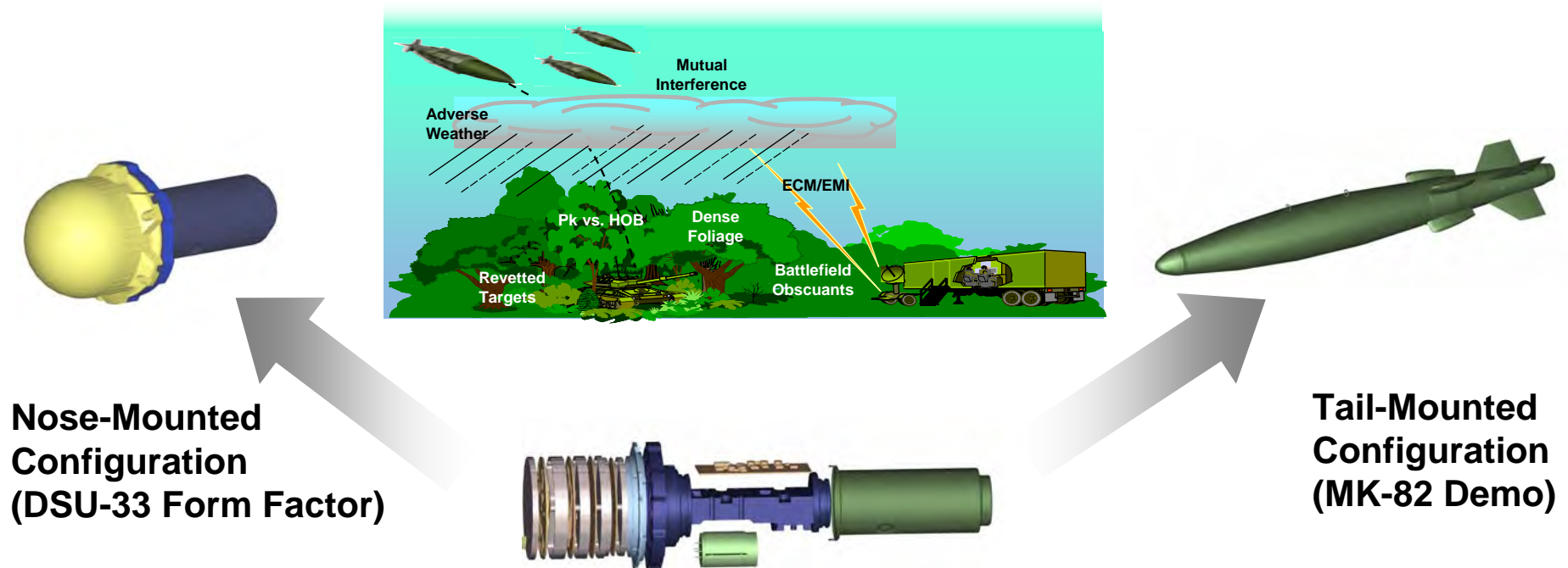
Fuze Air to Surface Technology (FAST)

A Precision HOB, Low Cost Ground Profiling Radar



Common Fuze Sensor for a Broad Spectrum of Weapons

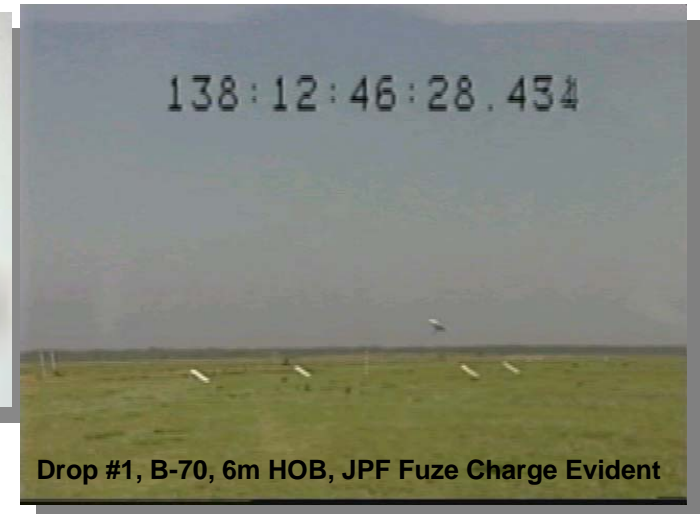
UHF to L-Band **Pulse Doppler Radar** Using Low Cost **COTS** Components
Nose and **Tail** Mount Configurations Only **Differ** in the **Antenna** Structure
Small Volume **Common Design** Provides Identical Requirements for **Any Weapon**



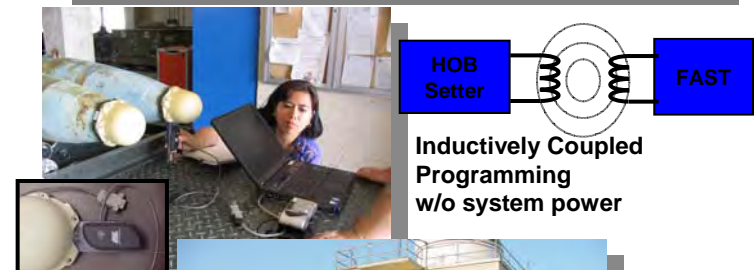
100% Common Low Cost Electronics and Operational Software



Operational Field Validation Testing (F-16, Mk-82 Unguided Inert Drops)



- Drop Tests (Piggybacking with DSU-33 VECP Testing)
- 4 FAST Drops on Mk-82s (B-70 & C-52)
- Demo HOB in Operational Environment (TRL 7!!)
 - Bomb Bodies Drilled to observe flash from Fuze charge
 - Telemetry (FAST equipped) and Range Data Analysis
 - HOB set (Inductive) at bomb dump after bomb buildup



TM Setup,
B-70



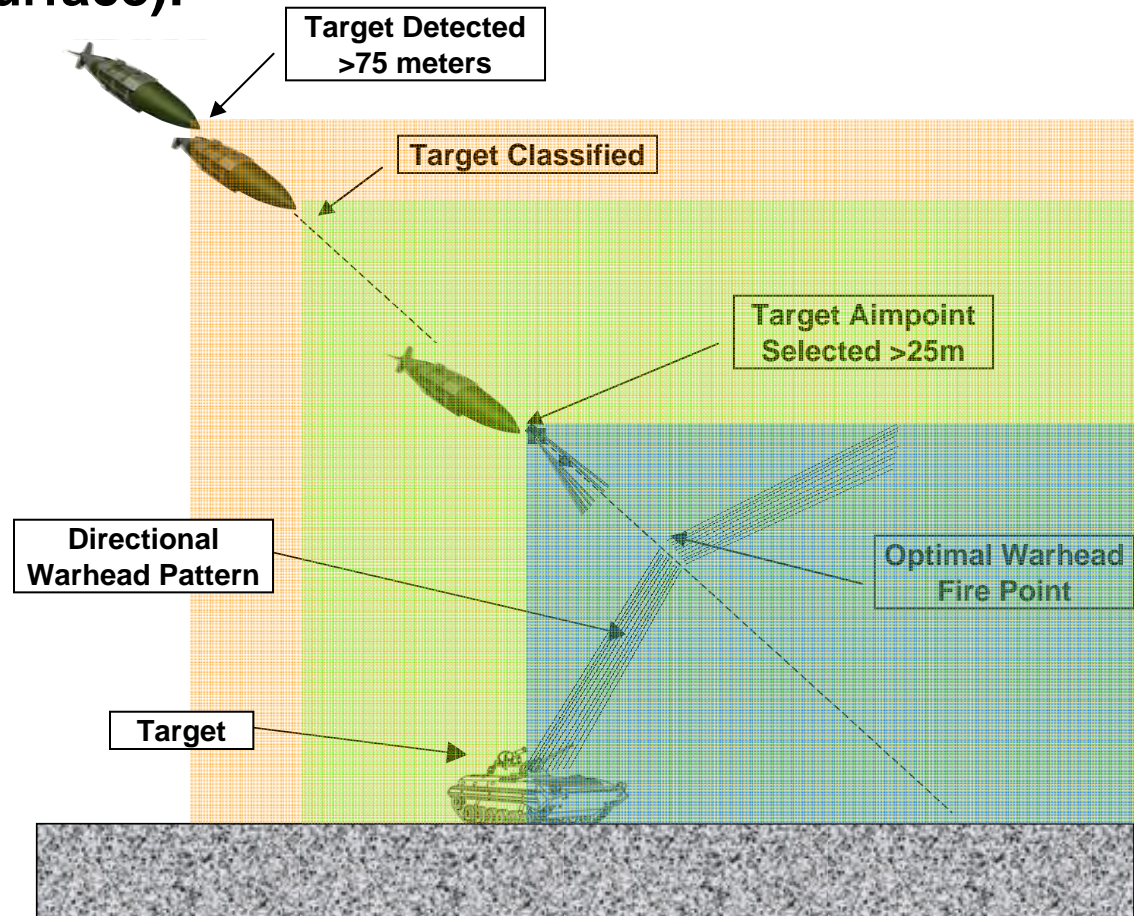
FOCAS Concept



- **Notional Engagement (Air-Surface):**

- A Proximity Fuze Sensor That:

- Separates The Target From Background Clutter
 - Calculates And Tracks The Target's Aimpoint
 - Selects The Correct Warhead Mode For The Given Encounter
 - Communicates The Warhead Mode And Firing Time To The Warhead Initiation System
 - Updates Solution Until Burst Time Is Reached

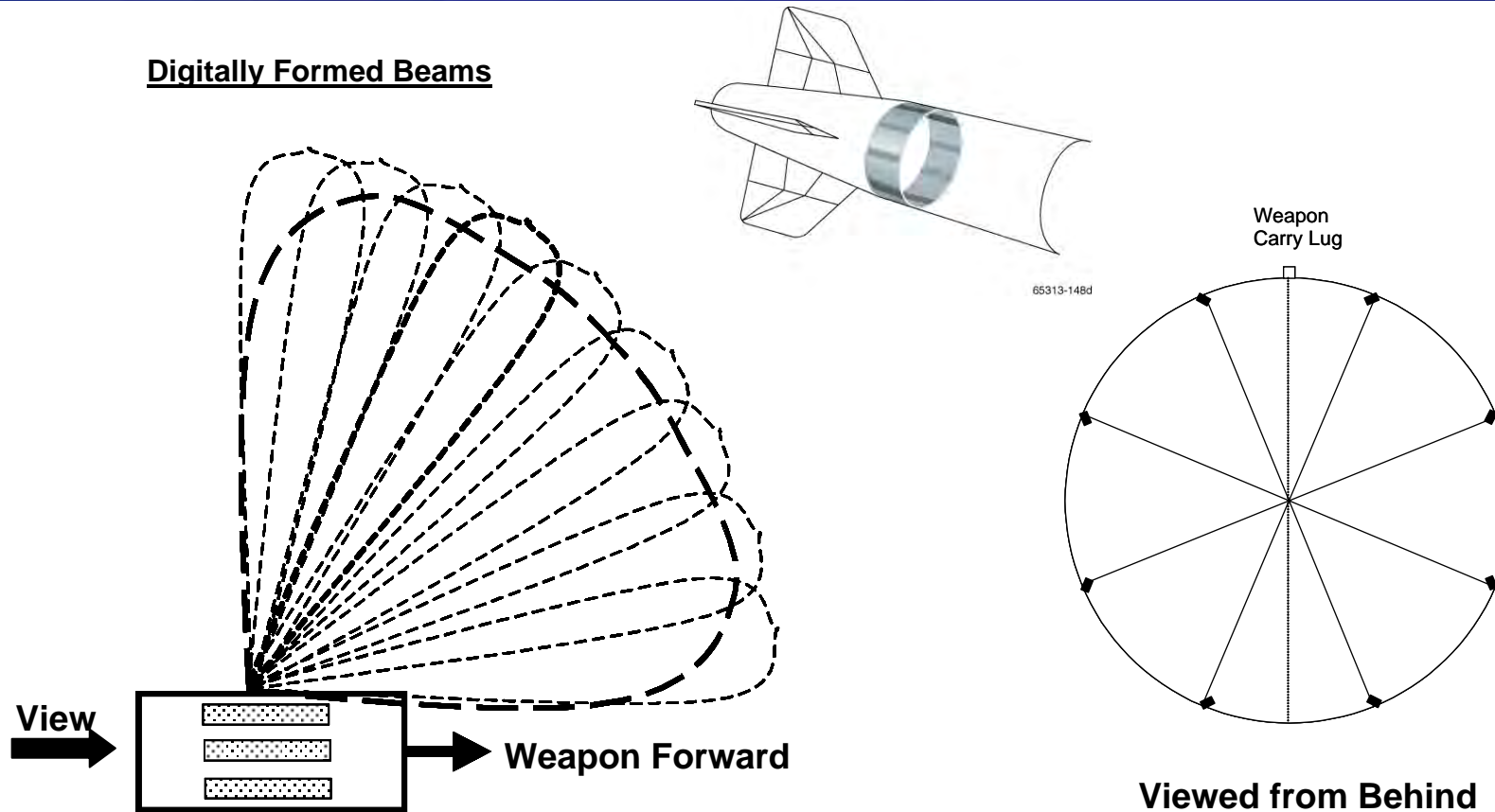




Imaging Millimeter Wave Antennas



Digitally Formed Beams



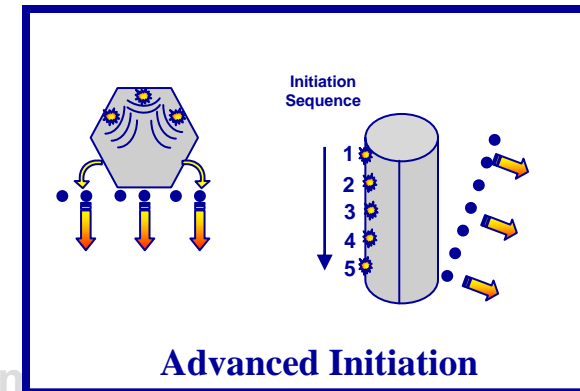
Simultaneously Receive on all Elements, Form Beams with Software



Fuze Challenges

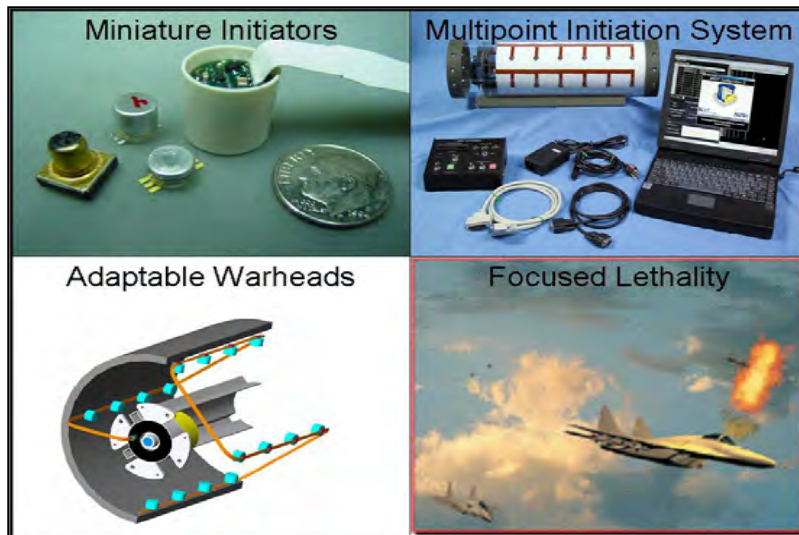


- Penetration Fuzing
 - Target Defeat
 - Target Denial
- Bomb Damage Sensing
 - Real-time bomb damage information from airborne platform
 - Two way, shock hard, through earth
- Point Burst
 - Ground profiling radar
 - Active imaging fuze sensor
- **Advanced Initiation**
 - Individually control multiple initiation points

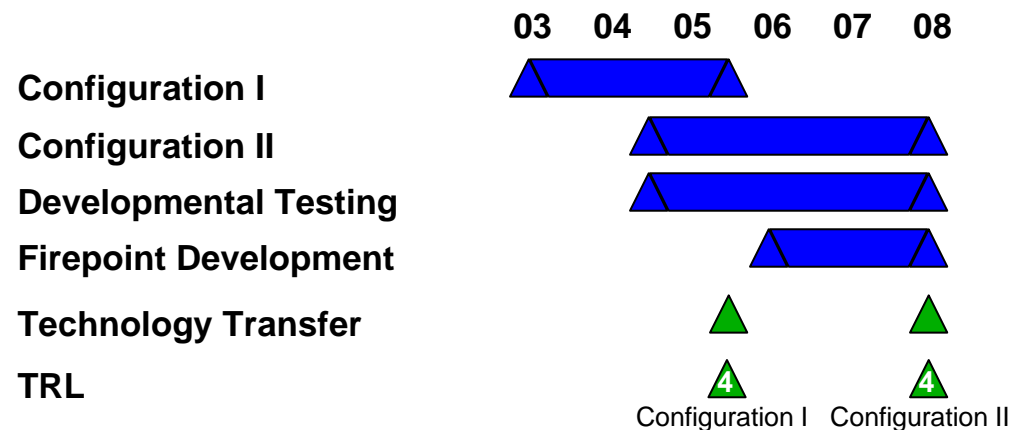




Adaptable Miniature Initiation System Technology (AMIST)



Technology Investment Schedule (FY)



Description	Benefits to the Warfighter
<ul style="list-style-type: none"> Develop two initiation configurations, each capable of controlling individual detonation points Configuration I provides non-autonomous capability only (requires continuous connection to mode controller) Configuration II provides fire point networking capability and fire point independence from mode controller 	<ul style="list-style-type: none"> Increases warhead lethality Decreases collateral damage Enables multiple kill mechanisms Provides multirole munition capability
Technology	
<ul style="list-style-type: none"> Miniature Initiation System Technology (MIST) Low Energy Initiators Pulse Discharge Switch Technologies 	



Summary and Way Ahead



- **High level AF recognition of fuze issues**
- **AFRL utilizing new construct for technology investment through Future Long Term Challenges**
- **Addressing fuzing technology scientific challenges with innovative solutions**
 - **Shock hardening electronics for extreme environments**
 - **Demonstrated through media transmission of fuze data**
 - **Demonstrated selectable fuze sensor in tactical configuration**
 - **Demonstrated independent control of multiple initiation points**